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(Nos. I. to III.—1885.)

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THE NATURAL HISTORY SECRETARY.

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"It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science in different parts of *Asia* will commit their observations to writing, and send them to the Asiatic Society at Calcutta. It will languish, if such communications shall be long intermitted; and it will die away, if they shall entirely cease." SIR WM. JONES.  
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No. II.—Containing pp. 69—126, with Plates I. and II., was issued on
12th September, 1885.

No. III.—Containing pp. 127—182, with Plates III. IV., and V., was
issued on 29th December, 1885.

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- I. *Cyrtophium calamicola.*
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ASIATIC SOCIETY OF BENGAL.

Part II.—NATURAL SCIENCE.

No. I.—1885.

I.—*Fourth List of Butterflies taken in Sikkim in October, 1884, with Notes on Habits, &c.*—By LIONEL DE NICEVILLE.

[Received 13th January;—Read April 1st, 1885.]

I have already contributed three papers to the Journal of this Society on the Rhopalocera taken near Darjiling in October. In the last of these papers, the number of species recorded as met with in this month is given as 284, which is increased in the present list to 313, or about twice the number of species found throughout the year in Calcutta. These species were all taken at low elevations, either in the Runjit Valley or on the roads between it and Darjiling, except in a few cases where other localities are given; and it is probable that many more species will be discovered when some of the other valleys and the higher elevations such as Senechal come to be explored.

LEPIDOPTERA RHOPALOCERA.

Family NYMPHALIDÆ.

Subfamily SATYRINÆ.

285. *Mycalesis (Calysime) blasius*, Fabricius.

A single male. In my previous paper,* I recorded that *M. perseus* was very rare in Sikkim. It appears that *M. blasius* is equally so, which accords with my lately expressed opinion that these hitherto supposed distinct species are in reality but one species, which should stand as *M. perseus*, the form that is usually called *blasius* occurring in the rains

* J. A. S. B. 1882, vol. li, pt. ii, p. 56, no. 136.

and the form *perseus*, in the dry weather. In the same way, *M. mineus* and *M. visala* must be united under the former name, the ocellated form (*M. mineus*) occurring in the rains, and the non-ocellated pointed-winged form (*M. visala*), in the dry season.

286. *Lethe scanda*, Moore.

Mr. Otto Möller took a single female specimen in perfect condition in Birch Hill Park, Darjiling, at 6,800 feet elevation. This sex has been twice separately described, by Mr. Moore as *Debis nada*, and by Mr. Druce as *Zophoessa dirphia*.

287. *Orinoma damaris*, Gray.

I took a single female specimen at 3,200 feet elevation. It differs from the male only in the wings being slightly broader, and the apex and outer margin of the forewing more rounded.

Subfamily MORPHINÆ.

288. *Stichophthalma camadeva*, Westwood.

I saw a single specimen of this splendid species. It is common in Sikkim in June and July.

Subfamily NYMPHALINÆ.

Symbrenthia hippocla, Cramer.

In the Proc. Zool. Soc. Lond. 1874, p. 570, Mr. Moore has described a species of *Symbrenthia* from Masuri under the name of *S. daruka*. I took a female specimen of a *Symbrenthia* on this occasion which I consider to be merely a casual variety or 'sport' of *S. hippocla*. It agrees with Mr. Moore's description of *S. daruka*, but has hardly any of the black ground-colour left, this varietal character being carried to even a greater extreme in it than in the specimen he described.

289. *Ergolis indica*, Moore.

A single male. This species is very doubtfully distinct from *E. ariadne*, Linnæus, which Mr. Moore has lately restricted to the island of Java.

290. *Limenitis danava*, Moore.

A single female taken at Singla, 1,000 feet elevation.

291. *Apatura sordida*, Moore.

One male taken in the Runjit Valley.

292. *Helcyra hemina*, Hewitson.

One female of this rare species.

Family LEMONIIDÆ.

Subfamily LIBYTHÆINÆ.

293. *Libythea myrrha*, Godart.

I took a single male in the bed of a hill stream.

Family LYCÆNIDÆ.

294. *Cyaniris marginata*, de N.

I took a single male at about 3,000 feet elevation.

295. *Nacaduba atrata*, Horsfield.

Three males.

296. *Nacaduba prox. viola*, Moore.

A single male. *N. viola* is recorded from Ceylon, but I have not seen a specimen from that locality. The expanse given for the ♂ is $\frac{9}{10}$ of an inch, while the Sikkim specimen measures $1\frac{3}{10}$ inches. The white bands on the underside as described by Mr. Moore appear to differ also: in *N. viola* the two inner and the outer ones are short; in the Sikkim specimen it is only the middle pair on either side of the discocellular nervules which are short, the other two pairs extending nearly across the wing.

Nacaduba ardates, Moore.

Mr. Distant in his recent work 'Rhopalocera Malayana' has divided the *Lycenidæ* into three groups, the first of which (*Curetaria*) lacks "filamentous tail-like appendages" to the hindwing, while the other two groups (*Castalaria* and *Aphnaria*) possess these tails. This year I took many specimens of a *Lycænid* in company with *N. ardates* which differed in no way from that species except in having no tails. On careful microscopic examination of these tailed and tailless forms, I can find no difference between them in respect of the venation; and as the markings are precisely similar, I conclude that they are one and the same species. Mr. Distant, in forming his three groups (p. 196), says that the presence or absence of the tail "may prove to be an uncertain and illusory divisional character" as an American naturalist has recorded that certain North American species have a tailless spring brood, and a summer tailed generation. In Sikkim, at any rate, both forms occur together, and in equal perfection as to condition. I have also received both forms from Orissa, collected by Mr. W. C. Taylor. Another species (*N. dana*, de N.) which when describing it I placed doubtfully in the genus *Nacaduba* has the venation of that genus, but no tails. It occurs at Buxa in Bhutan, in Sikkim, at Bholahât in the Malda district, in the Chittagong district, and at Ootacamund.

297. *Catochrysops bengalia*, de N.

One male.

298. *Sithon indra*, Moore.

One female.

299. *Sithon mandarinus*, Hewitson.

One male.

300. *Chliaria kina*, Hewitson.

I took a male only at about 3,000 feet elevation.

301. *Satadra atrax*, Hewitson.

Two females.

302. *Satadra bupola*, Hewitson.

Several examples. They differ from Hewitson's figure of that species in having an additional spot on the costa just beyond the spot closing the cell on the underside of the forewing.

303. *Satadra œnea*, Hewitson.

Three males and a female taken.

Family PAPILIONIDÆ.

Subfamily PIERINÆ.

304. *Delias belladonna*, Fabricius.

I took a single male at rest in the bed of a stream in nearly half an inch depth of running water.

Subfamily PAPILIONINÆ.

305. *Papilio (Sainia) protenor*, Cramer.

One male only.

306. *Papilio rhetenor*, Westwood.

Several males. This species has a male "sexual-mark" placed in a very unusual position, viz., on the underside of the hindwing just beyond the cell between the third median and discoidal nervules.

307. *Papilio (Chilasa) panope*, Linnæus.

A single male.

Family HESPERIIDÆ.

308. *Badamia exclamationis*, Fabricius.

This is a common species in Sikkim, but met with in October for the first time on this occasion.

309. *Halpe cerata*, Hewitson.

This is rather a rare species.

310. *Suastus aditus*, Moore.

This species was first described from the South Andamans. Mr. W. C. Taylor has obtained it in Orissa.

311. *Coladenia dhanada*, Moore.

One specimen.

312. *Thanaos kali*, de N.

313. *Thanaos jhora*, de N.

These two species occur together with *T. stigmata* settled on damp spots sucking up the moisture. On the wing, *T. kali* is easily distin-

guished from the other two species by its much larger size and deep black colour. It is much the rarest of the three. *T. stigmata* is the only described species of the genus having a male sexual mark on the upperside of the forewing.

II.—*Notes on Indian Rhynchota*, No. 2.—By E. T. ATKINSON, B. A.

[The notes are taken so far as possible from the original descriptions or from Stål, Signoret, Butler, or Distant, &c. where these writers have redescribed a species. The measurements of specimens not in the Indian Museum have been converted into millimetres from the recorded measurements of the several authors.]

[Received Feb. 17th;—Read March 4th, 1885.]

HOMOPTERA.

Family CERCOPIDÆ.

Cercopida, Stål, Hem. Afric. iv. p. 54 (1866): Hem. Fabr. ii. p. 11 (1869). Fieber, Rev. Mag. Zool. (3 sér.) iii. p. 328 (1875): *Cercopina* Stål, Ofvers. Kong. Vet. Aka. Förh. p. 718 (1870).

Frons convex or compressly produced: ocelli two on the vertex near the base: thorax, large, sexangular or trapezoidal: scutellum small or moderate, triangular; tegmina usually coriaceous: feet remote from the sides of the body with the coxæ (especially the posterior pair) short: tibiæ rounded, posterior furnished with one or two spines and with a circlet of spinules at the apex.

Subfamily CERROPINA, Stål.

Cercopida, Stål, Hem. Afric. iv. p. 55 (1866): Hem. Fabr. ii. p. 11 (1869): *Cercopina*, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 718 (1870).

Anterior margin of thorax straight, eyes equally long and broad.

In 1874, Mr. Butler of the British Museum (Cist. Ent. i. p. 245) recorded the species of the genera *Cosmoscarta* and *Phymatostetha*, formed by Stål from the genus *Cercopis* of Walker (*nec* Fabricius). He enumerated 104 species of the genus *Cosmoscarta* and 22 species of the genus *Phymatostetha*. Since then, the number of species of the genus *Cosmoscarta* has been increased by eight of which five, described by Mr. Distant, come from India and the Eastern Archipelago, and three, described by Mr. Butler, come from Penang and Sumatra. The number

of species of the genus *Phymatostetha* has been increased by two, of which one comes from Ceylon and one from Assam; both have been described by Mr. Distant. The Indian Museum possesses about ten, apparently undescribed, species which may be referred to these genera, and which will form the subject of a separate paper hereafter.

Genus COSMOSCARTA, Stål.

Hem. Fabr. ii. p. 11 (1869) : Ofvers. Kong. Vet. Aka. Förh. p. 718 (1870).

Frons very large, very tumid, obtuse, extended on the facial side almost to the eyes, devoid of any longitudinal furrow or keel.

1. COSMOSCARTA TRICOLOR, St. Farg. and Serv.

Cercopis tricolor, St. Fargeau and Serville, Enc. Méth. x. p. 605 (1825) : Burm. Handb. Ent. ii. (i) p. 124 (1835) : Walker, J. L. S. Zool. i. p. 95 (1856) ; *ibid.*, p. 165 (1857).

Cosmoscarta tricolor, Butler, Cist. Ent. i. p. 245 (1874) : Distant, J. A. S. B. xlviii (2) p. 38 (1879).

Black, shining : head, thorax, scutellum towards the tip, hind borders of the abdominal segments, the tip of the abdomen and the legs, red : femora black, the four anterior red towards the tips : six red spots on each tegmen at the base. A Tenasserim variety in the Indian Museum differs from the type in having the subbasal fascia represented by a transverse series of four sanguineous spots ; there is also a spot of the same colour at the base. It is thus intermediate between *C. tricolor* and *C. basinotata*, Butler (Cist. Ent. i. p. 245), which differs also in the coloration of the abdomen (*Distant*). Body long 22 : exp. teg. 51 millims.

Reported from Borneo, Java, Singapore, and Tenasserim ; a specimen from the last locality is in the Indian Museum.

2. COSMOSCARTA BASINOTATA, Butler.

Cosmoscarta basinotata, Butler, Cist. Ent. p. 245, t. viii, f. 2, (1874) : Distant, J. A. S. B. xlvii (2) p. 194 (1878).

Form of *C. tricolor* : differs chiefly in having the tegmina crossed at the base by a patch of six red spots (that on the clavus being more or less bifid) instead of the pale testaceous band, and in the narrower and interrupted red bands margining the segments on the dorsum of the abdomen (*Butler*). Long. 21 : exp. teg. 47 millims.

Reported from Sarawak, Tenasserim.

3. COSMOSCARTA MOOREI, Distant.

Cosmoscarta moorei, Distant, Trans. Ent. Soc. Lond. p. 321 (1878.)

Black, shining: tegmina with the base both above and below carmine. This coloration consists of a narrow straight subcostal streak of about 3 millims. in length and a broader claval streak of about the same length, gradually rounded and narrowed at its termination: wings fuscous; costal edge, for about half the length, narrowly tinged with carmine: eyes luteous: posterior border of scutellum, metanotum, and abdominal segments, apex and lateral borders of abdomen, carmine: anterior legs dull reddish, femora furnished with a strong spine; intermediate legs pitchy: mesosternum with two very large conical, thick teeth. Body long 13: exp. teg. 35 millims.

Reported from Sikkim.

4. COSMOSCARTA FUSCIPENNIS, St. Fargeau.

Cercopis fuscipennis, St. Farg. & Serv., Enc. Méth. x. p. 605 (1825.)

Cercopis plana, Walker, List Hom. B. M. iii. p. 653 (1851): J. L. S. Zool. i. p. 95 (1856): *ibid.* x. p. 276 (1867).

Cosmoscarta fuscipennis, Stål, Hem. Fabr. 2 p. 11 (1869): Butler, Cist. Ent. i. p. 246 (1874).

Black: head, chest, rostrum except its black tip, and the fore-border of the tegmina from one to two-thirds of its length, red: wings dark grey. Thorax sometimes with two black points. Body long 12: exp. teg. 27 millims.

Reported from Java, Penang, Mount Ophir, Malabar (*Walker*).

5. COSMOSCARTA MEGAMERA, Butler.

Cercopis nigripennis, Walker (*nec* Fabricius), List Hom. B. M. iii. p. 653 (1851).

Cosmoscarta megamera, Butler, Cist. Ent. i. p. 246, t. viii. f. 3 (1874): Distant, J. A. S. B. xlviii. (2), p. 38, (1879).

Form and general coloration of *C. fuscipennis* (St. Fargeau), but at once distinguished by its much greater size, black legs, the narrower reddish costal edge and less pronounced basal reddish diffusion on tegmina. The colour of the thorax and head also varies from piceous to castaneous and bright testaceous (*Butler*). Body long 16—19: exp. teg. 39—47 millims.

Reported from Hong-Kong, Laos, Java, Penang, Tenasserim, Silhat: the Indian Museum possesses specimens from Sikkim, Sibságar, Nága Hills, and Tenasserim.

6. COSMOSCARTA FUNERALIS, Butler.

Cosmoscarta funeralis, Butler, Cist. Ent. i. p. 247, t. viii. f. 4 (1874).

Form of *C. fuscipennis*, St. Far. & Serv., but thorax with a distinct central ridge: head and thorax dark castaneous; scutellum piceous,

dorsum of abdomen reddish-orange; tegmina piceous, almost black; wings fuscous; pectus black; venter and legs red; segments transversely banded and laterally spotted with black; proximal extremities of femora blackish (*Butler*). Body long 20: exp. teg. 41 millims.

Reported from India.

7. COSMOSCARTA MASONI, Distant.

Cosmoscarta masoni, Distant, J. A. S. B. xlvii (2); p. 194 (1878): xlviii. (2), p. 40, t. ii, f. 6, (1879).

Pronotum stramineous with a quadrate black spot on the anterior margin: head (except basal portion), and eyes luteous: tegmina, pectus, legs, and abdomen shining black: prosternum with lateral borders stramineous: wings dark fuscous with the veins black ♀. Body long (excl. teg.) 17: exp. teg. 45 millims.

Reported from Burma, Tenasserim: type from the latter locality in the Indian Museum.

8. COSMOSCARTA VIRIDANS, Guérin.

Cercopis viridans, Guérin, Voy. Bél. Ind. Orient. p. 501; Atlas, t. 3, f. 7, 7a (1834): Walker, List Hom. B. M. iii. p. 654, (1851); J. L. S. Zool. x. p. 279, (1867).

Cercopis latissima, Walker, List Hom. B. M. iii. p. 655, (1851).

Cosmoscarta viridans, Butler, Cist. Ent. i. p. 249, (1874).

Black, shining: tegmina shining metallic blackish-green, convex along the fore-margin which is dilated towards the base; wings fuscous, veins black, rostrum, feet, and anus coccineous. Body long 15: exp. teg. 46 millims.

Reported from Coromandel, Java, Sumatra, Mysol, New Guinea.

9. COSMOSCARTA EGENS, Walker.

Cercopis egens, Walker, List Hom. B. M. Suppt. p. 171, (1858).

Cosmoscarta egens, Butler, Cist. Ent. i. p. 255, (1874).

Thorax and head black, shining: scutellum, metanotum, abdomen at the base and along the posterior margin of each segment, and the legs red: tegmina very red at the base and with a roseate band before the reticulated apical third, this band is sometimes narrow or indistinct or even obsolete: wings brown, rosy red at the base and along the adjoining part of the costa. Body long 11: exp. teg. 31 millims.

Reported from India, Penang: the Indian Museum possesses specimens from the Nāga and Khasiya hills.

10. COSMOSCARTA DUCENS, Walker.

Cercopis ducens, Walker, List Hom. B. M. iii. p. 655, (1851): Stål, A. S. E. F. (4 sér.) v. p. 188, (1865).

Cosmoscarta ducens, Butler, Cist. Ent. i. p. 255, (1874).

Black, rostrum and legs piceous; abdomen shining violaceous; tegmina blackish-brown with two narrow, slightly undulating, sordid sanguineous bands; one, near the base; the other, at two-thirds of the length: wings dark brown, veins black. Body long, 16: exp. teg. 40 millims.

Reported from Silhat: the Indian Museum possesses a specimen from the Nága hills.

11. COSMOSCARTA LYDIA, Stål.

Cercopis lydia, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 149, (1865).

Cosmoscarta lydia, Butler, Cist. Ent. i. p. 257, (1874).

Brick red or saffron-yellow: head, anterior part of thorax, scutellum (except the frena), tegmina, anterior lateral part of prostethium, metastethium, anus and tarsi, black: base of the tegmina brick-red or saffron-yellow: wings sordidly hyaline, apex very slightly infusate, base palely saffron. Body long 8—10: exp. teg. 20—23 millims.

Sometimes tegmina have no saffron bands and sometimes have two, one before and the other behind the middle.

Reported from E. India.

12. COSMOSCARTA TRIGONA, Walker.

Cercopis trigona, Walker, List Hom. B. M. iii. p. 660, (1851).

Cercopis amplicollis, Walker, l. c. Suppt. p. 175, (1858).

Cosmoscarta trigona, Butler, Cist. Ent. i. p. 257, (1874).

Thorax metallic bluish-black, shining: borders of scutellum, posterior margin of segments of abdomen, the anus, coxæ and femora, and the tarsi at the base, red: tegmina bluish-black, tips brown, with a bifurcated basal streak and two bands, red; the basal streak with the median band contain between them an almost triangular patch, bluish black: the limb of the basal bifurcation on the hind border is much broader than that on the costal margin, neither quite reach the median band. Body long 10—12: exp. teg. 23—29 millims.

Reported from N. India.

The Indian Museum possesses specimens from the Khasiya and Nága hills, the Dhansiri valley, and Sibságar.

13. COSMOSCARTA DECISA, Walker.

Cercopis decisa, Walker, List Hom. B. M. Suppt. p. 175, (1858).

Cosmoscarta decisa, Butler, Cist. Ent. i. p. 258, (1874).

A second species described under this name by Walker (in J. L. S. Zool. x. p. 278, No. 296, 1867) has been renamed *C. zonata* by Butler (in Cist. Ent. i. p. 253, 1874). Walker describes *C. decisa* thus: "Black: head above and prothorax æneous-green, shining: prothorax

with a very indistinct keel: tegmina whitish testaceous at the base and with two whitish testaceous bands; middle band almost equal in breadth and parallel to the basal one; exterior band contracted hindward: wings greyish-vitreous." Body long $7\frac{1}{2}$: exp. teg. 17 millims.

Reported from Darjiling. The Indian Museum possesses a specimen from Sikkim.

14. COSMOSCARTA UNDATA, Walker.

Cercopis undata, Walker, List Hom. B. M. iii. p. 659, (1851): Stål, Ofvers. Kong. Vet. Aka. Förh., p. 148, (1865).

Cosmoscarta undata, Butler, Cist. Ent. i. p. 258, (1874).

Black: abdomen shining violaceous: thorax and the spots or bands on tegmina croceous or rufous-testaceous; an anterior transverse spot on the thorax and the posterior part, black: wings slightly infuscate, veins rufescent towards the base.

Var. *a*. Posterior half of thorax black: tegmina with almost the fifth basal part, posteriorly sinuated, a waved band a little before the middle, somewhat interrupted towards the claval suture, also a band beyond the middle, produced posteriorly in its middle, sometimes divided into three spots, rufous-testaceous. Body long 13: exp. teg. 30 millims.

This variety is reported from the Himálaya and the Indian Museum possesses specimens from Sibságar, Assam, and Arakan.

Var. *b*. about the fourth basal part of the thorax, black: tegmina with a waved band before the middle, twice subinterrupted, emitting at the costal and scutellary margins a stripe, sinuated within, also with three spots disposed in a curved row beyond the middle, the two exterior often confluent, rufous-testaceous. Body long 9—10: exp. teg. 24 millims.

Reported from Penang.

15. COSMOSCARTA BISPECULARIS, White.

Cercopis bispecularis, White, A. & M. N. H. xiv. p. 426, (1844): Walker, List Hom. B. M. iii. p. 656, (1851): Stål, Stettin Ent. Zeit. xxii. p. 153, (1866).

Cosmoscarta bispecularis, Butler, Cist. Ent. i. p. 259, (1874).

Cinnabar, shining: thorax with two very large, nearly oval, black spots in front of which are two small, nearly round, black spots; pectus black; underside of abdomen with two black bands: tegmina with a short black stripe at the base, near which three united black spots form a curved band across the wing; another band is formed in the middle by three separate black spots; reticulated part at the tips brown; wings grey, red at the base, brownish along the hind borders and at the tips. Body long 11—12 exp. teg. 26—29 millims.

Reported from India, Almora, N. W. P., Penang: the Indian Museum possesses specimens from Assam.

16. COSMOSCARTA DORSIMACULA, Walker.

Cercopis dorsimacula, Walker, List Hom. B. M. iii. p. 658, (1851) : J. L. S. Zool. i. p. 95, (1856) : *ibid.* p. 165, (1857).

Cercopis quadrimaculata, Walker, l. c. p. 661, (1851).

Cosmoscarta dorsimacula, Butler, Cist. Ent. i. p. 259, (1874).

Walker's *Cercopis dorsimacula* in List Hom. l. c. p. 663, No. 41, is different and was renamed by him *Cercopis tomentosa* in J. L. S. Zool. x. p. 284, (1867) : it now stands as *Phymatostetha stellata*, Guérin (*q. v.*).

Bright red shining : head with a short transverse streak along each side of the hind border ; thorax with two very large black spots on each side of the disc and two smaller spots in front ; pectus and abdomen towards the base, black : a row of black spots on each side of the abdomen, of which the underside, except the hind borders of the segments, is black ; tegmina red with seven black spots, six large and more or less confluent form two curved bands ; reticulated part lurid : wings lurid, red at the base ; veins brown, red towards the base (*Walker*). Body long 12—14 : exp. teg. 36—39 millims.

Var. *a.* abdominal segments with black bands.

Var. *b.* Body and tegmina testaceous with the usual spots.

Reported from N. Bengal.

17. COSMOSCARTA FICTILIS, Butler.

Cosmoscarta fictilis, Butler, Cist. Ent. i. p. 259, (1874).

Allied to preceding but differs in its usually smaller size, narrower thorax, duller and more uniform colouring and much smaller and more regularly uniform black spots (*Butler*). Body long 12 : exp. teg. 32 millims.

Reported from Penang, India, Silhat.

18. COSMOSCARTA DORSALIS, Walker.

Cercopis dorsalis, Walker, List Hom. B. M. iii. p. 658, (1851).

Cercopis connexa, Walker, List l. c. p. 663, (1851).

Cercopis ramosa, Walker, Ins. Saunds. Hom. p. 85, (1858).

Cosmoscarta dorsalis, Butler, Cist. Ent. i. p. 260, (1874).

Walker describes *C. dorsalis*, thus :—"Piceous shining ; shield very minutely punctured, impressed on each side in front ; tibiæ and feet ferruginous ; tegmina red, black on the reticulated part ; eight large, partly confluent, black spots on membranous part : wings brown, veins black." Body long 9 : exp. teg. 25 millims.

Reported from N. India.

19. COSMOSCARTA PALLIDA, Walker.

Cercopis pallida, Walker, List Hom. B. M. iii. p. 657, (1851).

Cercopis ferruginea, Walker, List l. c. p. 660, (1851).

Cosmoscarta pallida, Butler, Cist. Ent. i. p. 265, (1874).

Walker describes *C. pallida*, thus:—"Testaceous, head black, transversely striated, very convex in front: rostrum testaceous: abdomen brown, testaceous at the base, and at the tip: tips of the feet brown: tegmina lurid, brown towards the tips: wings grey, veins brown." Body long 11-13: exp. teg. 29-33 millims.

Reported from India.

20. COSMOSCARTA ELEGANTULA, Butler.

Cosmoscarta elegantula, Butler, Cist. Ent. i. p. 265, (1874).

Allied to preceding: head and thorax metallic greenish black: abdomen purplish black, castaneous at the tip: tegmina piceous, veins of basal half testaceous: base and a transverse band at end of second third reddish-orange: wings slightly fuscous; base rufescent (*Butler*). Body long 8: exp. teg. 20 millims.

Reported from India.

21. COSMOSCARTA PICTILIS, Stål.

Cercopis pictilis, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 249, (1854).

Cosmoscarta pictilis, Butler, Cist. Ent. i. p. 266, (1874).

Obscurely green chalybeous; scutellum on both sides at the base and at the apex weakly spotted with cinnabar: tegmina sordidly white, basal margin and two bands weakly cinnabar; two spots, one smaller before the first band and the other between the bands and the apex nigro-fuscous: femora red; tibiæ blackish. Long, 16; breadth of pronotum 6 millims. Butler writes that it seems allied to *P. signifera*, Walker from the description and in that case would be a *Phymatostetha*.

Reported from E. India.

22. COSMOSCARTA BOREALIS, Distant.

Cosmoscarta borealis, Distant, Trans. Ent. Soc. p. 321, (1878).

Head and pronotum luteous, antennæ black: abdomen and tegmina roseate, ocelli black, eyes luteous thickly covered with blackish markings: wings pale fuscous: pectus, coxæ, and femora luteous, fore and median tibiæ black, hind tibiæ luteous with the apex black: the tip of the rostrum, tarsi, and a strong spine near the apex of the hind tibiæ, black. Body long 6: exp. teg. 17 millims.

Reported from the Khasiya hills.

23. COSMOSCARTA ANDAMANA, Distant.

Cosmoscarta andamana, Distant, Trans. Ent. Soc. p. 175, (1878): Waterhouse, Aids Ident. Ins. i. t. 58 (1880-82).

Sanguineous, finely and closely punctured: tegmina with a broad band across the middle and the apex broadly black: these bands are united at the inner margin, sometimes very broadly: wings sordidly hyaline with veins much darker, base slightly sanguineous: femora, tibiae and tarsi piceous, hind tibiae with an acute spine (*Distant*). Body long 9: exp. teg. 24 millims.

Reported from the Andaman Islands.

Genus PHYMATOSTETHA, Stål.

Ofvers. Kong. Vet. Aka. Förh. p. 721, (1870).

Frons tumid, seldom forming an angle below the middle, without a keel or longitudinal impression. Ocelli nearer each other than the eyes. Thorax with the posterior margin before the scutellum slightly sinuated posterior lateral margins straight or sinuated. Mesosternum furnished posteriorly with two conical tubercles. Feet moderate, posterior tibiae armed with one or two spines.

24. PHYMATOSTETHA STÅLI, Butler.

Tomaspis circumducta, Stål (*nec* Walker), Ofvers. Kong. Vet. Aka. Förh. p. 150, (1865).

Phymatostetha circumducta, Stål l. c. p. 721, (1870).

Phymatostetha stålii, Butler, Cist. Ent. i. p. 267, (1874).

Blackish: frons, apices of the lobes of the vertex, apical and lateral margins of anterior part of the thorax, scutellum before the middle, two bands on the tegmina, equally removed from each other and from the base and the apex, the anterior small stripe on the corium, and the scutellary limbus of the clavus beyond the middle, sordidly lutescent: apical limbus of corium pellucid fuscous: wings fuscous, subsanguineous at the base: scutellum subequilateral; mesostethium with two distinct obtuse tubercles. Body long 14: exp. teg. 34 millims.

Reported from E. India.

25. PHYMATOSTETHA CIRCUMDUCTA, Walker.

Cercopis circumducta, Walker, List Hom. B. M. Suppt. p. 175, (1858).

Cercopis costalis, Walker, List, l. c. iii. p. 664, (1851).

Phymatostetha circumducta, Butler, Cist. Ent. i. p. 268, (1874).

The name *C. costalis* (l. c. iii. p. 664), had already been given to a local form of *C. theora*, White, by Walker (l. c. iii. 651) and was subsequently changed by him to *C. circumducta* for this species.

Black : head shining : frons with a semicircular luteous band which is prolonged in a conical form to the face which on each side is yellow : rostrum yellow, tip pitchy : prothorax with a luteous band along the fore border extending on each side to the base of the tegmina, scutellum lurid on each side ; pectus with large yellow marks on each side : abdomen purplish black with yellow bands at the tip, ventral surface yellow with three rows of transverse black spots, the side rows on the edge : legs tawny, femora and fore tibiæ brown, femora yellow beneath : tegmina dark brown with two narrow pale red bands, one at one-third, the other at two-thirds of the length, a yellow stripe extending along the fore-border from the base to the first band where it acquires a tawny hue, a pale red stripe extending along the hind-border from the base nearly to the first band : wings pale brown, almost colourless in part of the disc, luteous at the base, veins black (*Walker*). Body long 12 : wings long 15 millims. A variety has two subapical spots on the tegmina red.

Reported from Malabar, Singapore.

26. PHYMATOSTETHA HILARIS, Walker.

Cercopis hilaris, Walker, List Hom. B. M. iii. p. 665, (1851).

Phymatostetha costalis, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 721, (1870).

Phymatostetha hilaris, Butler, Cist. Ent. i. p. 268, (1874).

Black : head shining ; frons with a semicircular luteous band which is prolonged in a very broad conical form and occupies the disc of the face : the latter is pitchy, sides and epistoma yellow, rostrum yellow with a black tip : prothorax with a luteous band along the fore-border, extending on each side to the base of the tegmen : pectus yellow, disc black : with 2—3 black spots on each side : abdomen purple, under-side yellow with three rows of transverse black spots, the side rows on the edge which is very broad : tegmina dark brown with two narrow yellow bands : the first at one-third of the length, interrupted on the disc and marked by some dots thence to the hind border ; the second, at two-thirds of the length, slightly waved : a yellow spot on the disc between it and the tip ; a yellow stripe extending along the fore border from the base to the first band : wings greyish, tinged with brown at the tips and along the hind borders, luteous at the base. Body long 10 : exp. teg. 25 millims (*Walker*). Stål, l. c. makes this a synonym of *C. costalis*, Walker.

Reported from Malabar.

27. PHYMATOSTETHA STELLATA, Guérin.

Cercopis stellata, Guérin, Icon. Règne Anim. Texte. p. 368, (1829-44) : Stål, Ofvers. Kong. Vet. Aka. Förh. p. 150, (1865).

Cercopis dorsimacula, Walker, List. Hom. B. M. iii. p. 663, (1851) : J. L. S. Zool. i. p. 95, (1856).

Cercopis tomentosa, Walker, J. L. S. Zool. x. p. 284, (1867).

Phymatostetha stellata, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 721, (1870) : Butler, Cist. Ent. i. p. 269, (1874).

Black, dull : head with a band in front of the eyes, two spots on the disc of the thorax, the lateral margins of the thorax, a spot on each side of the scutellum at the base, eight spots on each tegmen of which one is at the base, three are costal or subcostal, three near the hind-broader and one near the tip, luteous : narrow apical limbus, lurid : wings brown, rufescent at the base, veins black. Body long 17 : exp. teg. 37 millims.

Reported from Malabar, Malacca, Sumatra : the Indian Museum possesses a specimen from Johore.

28. PHYMATOSTETHA DORSIVITTA, Walker.

Cercopis dorsivitta, Walker, List Hom. B. M. iii. p. 662, (1851).

Var. *Cercopis humeralis*, Walker, List l. c. p. 662, (1851).

Phymatostetha dorsivitta, Butler, Cist. Ent. i. p. 269, (1874).

Black slightly shining : head red, black on each side in front and along the hind border : thorax with three red stripes, the side pair oblique and extending on each side from the fore border to the base of the tegmina; abdomen purple above, red at the tip and on each side : tegmina bluish brown with seven red spots, three costal or subcostal, three on hind border, and one on the disc near the tip which is lurid and occupies the apical fourth of the tegmen : wings pale brown, red at the base. Body long 18 : exp. teg. 42 millims.

Reported from N. India, Almora N. W. P., Silhat.

29. PHYMATOSTETHA PUDICA, Walker.

Cercopis pudica, Walker, Ins. Saunders. Hom. p. 84, (1858).

Phymatostetha pudica, Butler, Cist. Ent. i. p. 269, (1874).

Allied to *P. signifera*.

Reported from Silhat.

30. PHYMATOSTETHA SIGNIFERA, Walker.

Cercopis signifera, Walker, List Hom. B. M. iii. p. 655, (1851).

Tomaspis signifera, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 151, (1865).

Phymatostetha signifera, Stål, l. c. p. 721, (1870) : Butler, Cist. Ent. i. p. 270, (1874).

Blackish : frons before the middle, lobes of the vertex, a median stripe on the thorax and anterior lateral margins, scutellum, almost third basal part of the tegmina, pectus, venter, and feet stramineous : the stramineous portion of the tegmina with three irregular brown spots ; beyond these, two arched patches and a transverse patch and the apical

36. CALLITETTIX PRODUCTA, Stål.

Callitettix producta, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 153, (1865).

Black, very finely punctured; apex of scutellum, the tegmina, abdomen, and feet, reddish testaceous: frons tumid, forming a nearly straight angle, rounded at apex, without a keel: thorax hardly broader than long, lateral margins of fore part a little shorter than the anterior margin: tegmina narrow, slightly amplified towards the apex. Body long 7: exp. teg. 16 millims. ♀.

Reported from E. India.

37. CALLITETTIX VERSICOLOR, Fabr.

Cicada versicolor, Fabricius, Ent. Syst. iv. p. 50, (1794): Syst. Rhyn. p. 69, (1803).

Callitettix versicolor, Stål, Hem. Fabr. ii. p. 11, (1869).

Black shining, fuscous-pubescent; tegmina with a spot before the middle of the clavus and a subtransverse spot on the corium placed between the middle of the corium and the base, white; two spots behind the middle of the corium, the external large, transverse; the internal small, obsolete, placed at the apex of the clavus, sanguineous: wings uncoloured, apical margin slightly infusate. Body long with the tegmina $11\frac{1}{2}$ — $12\frac{1}{2}$: breadth of pronotum 3— $3\frac{1}{2}$ millims. ♀.

Reported from Tranquebar.

Subfamily APHROPHORINA, Stål.

Aphrophorida, Stål, Hem. Afric. iv. p. 55, 66 (1866): *Aphrophorina*, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 722, (1870): Scott. E. M. M. vii. p. 241, (1871).

Anterior margin of thorax round or angular, eyes usually transverse; scutellum flat, triangular.

Genus PTYELUS, St. Fargeau & Serville.

Body very large: head somewhat narrower than the thorax or of the same breadth, short, anteriorly obtusely and roundly subangulated, entire anterior margin obtuse; frons slightly convex, transversely obsoletely sulcated, clypeus not extending beyond the apex of the anterior coxæ: ocelli almost equally distant from each other and from the eyes or a little more distant: thorax finely rugose, quadrangular, anterior margin broadly rounded: scutellum longer than broad: tegmina subcultri-form, narrowed towards the apex, very densely punctured: apical area of wing behind the second anastomosis posteriorly acuminate, not reaching the intramarginal vein: posterior tibiæ bispinose.

I have not transcribed the descriptions of the following species attributed to *Ptyelus* by Mr. Walker as it is very doubtful whether they would be considered as belonging to it now and no representatives apparently exist in the collection of the Indian Museum.

38. *PTYELUS CONIFER*, Walker.

Ptyelus conifer, Walker, List. Hom. B. M. iii. p. 711, (1851).

Body long 6 : exp. teg. 17 millims. Reported from N. India.

39. *PTYELUS QUADRIDENS*, Walker.

Ptyelus quadridens, Walker, List Hom. B. M. iii. p. 711, (1851).

Body long 8 : exp. teg. 17 millims. Reported from N. India, N. Bengal.

40. *PTYELUS SEXVITTATUS*, Walker.

Ptyelus sexvittatus, Walker, List Hom. B. M. iii. p. 715, (1851).

Body long $5\frac{1}{2}$: exp. teg. $12\frac{1}{2}$ millims. Reported from N. India.

41. *PTYELUS PUNCTUM*, Walker.

Ptyelus punctum, Walker, List. Hom. B. M. iii. p. 718, (1851).

Body long $5\frac{1}{2}$: exp. teg. 12 millims. Reported from N. Bengal.

42. *PTYELUS SUBFASCIATUS*, Walker.

Ptyelus subfasciatus, Walker, List. Hom. B. M. iii. p. 724, (1851).

Body long 4 : exp. teg. 8 millims. Reported from N. India.

Genus *APHROPHORA*, Germar.

Mag. Ent. iv. p. 50, (1821) : Amyot and Serville, Hist. Nat. Ins. Hém. p. 563, (1843) : Scott, E. M. M. vii. p. 271, (1870) : Fieber, Rev. Mag. Zool. (3 Sér.) iii. p. 382, (1875).

Head almost as broad as the prothorax : vertex almost horizontal and somewhat flattened ; anterior margin sometimes rounded, generally very obtusely angulated : clypeus of variable length, reaching to or beyond the first pair of coxæ : rostrum long, 2—3 jointed ; ocelli two or sometimes absent ; when present placed near the posterior margin of the vertex and more or less remote from the eyes. Pronotum hexagonal or trapezoidal with a longitudinal keel continued through the vertex ; anterior margin rounded or obtusely angulated, posterior margin frequently deeply angulate-emarginate, scutellum triangular, shorter than the thorax. Tegmina slightly coriaceous, ovally elongate, acuminate : wings with the inferior nerve furcate from the base or before the middle. Posterior tibiæ armed with 1—2 spines and a circle of spinules at the tip.

43. *APHROPHORA SIGILLIFERA*, Walker.

Aphrophora sigillifera, Walker, List Hom. B. M. iii. p. 700, (1851),

Testaceous shining : head and thorax flat, with a slight yellow keel rudely punctured, thinly covered with tawny down : head above short mostly pitchy, slightly concave on the posterior margin, rather more convex in front ; its length less than one-fourth of its breadth ; face ferruginous, partly pitchy, slightly convex, with a very narrow yellow stripe which is most distinct towards the epistoma and is there traversed by two slightly curved yellow bands, one large, the other shorter and narrower ; on each side, are about ten oblique, slightly curved transverse ridges : rostrum ferruginous with a pitchy tip : pectus with a short, broad, black band between the fore and middle legs : abdomen luteous, reddish on each side and beneath : legs ferruginous, spotted with yellow, hind femora yellow : tegmina lurid, thickly punctured, narrow and conical towards the tips which are almost acuminate, brownish along part of the fore-border, on each side of a large subquadrate whitish spot which is in the middle : wings almost colourless, veins black, tawny at the base (*Walker*). Body long 7 : wings long 15 millims.

Reported from N. India.

Genus *CLOVIA*, Stål.

Hem. Afric. iv. p. 68, 75 (1866) : Ofvers. Kong. Vet. Aka. Förh. p. 723, (1870).

Head as broad as the thorax, rounded or roundly subangulated, varying in length, above flat, anterior margin of the lobes of the vertex acute, not furrowed ; frons somewhat convex, clypeus moderately produced at the apex, not extending beyond the apex of the anterior coxæ : position of ocelli variable : thorax sexangular with the anterior lateral margins usually very short, parallel or very slightly diverging backwards, scutellum longer than broad : tegmina with the commissural margin beyond the apex of the clavus subangulated or a little rounded : posterior tibiæ bispinose (*Stål*).

44. *CLOVIA GUTTIFER*, Walker.

Ptyelus guttifer, Walker, List Hom. B. M. iii. p. 712, (1851).

Clovio guttifer, Stål, Hem. Afric. iv. p. 75, (1866).

Lurid : head and thorax flat, finely punctured, thickly tawny pubescent ; head with a short yellow band and two black dots on fore-border ; face yellow, with a flat, middle stripe, on each side of which are nine oblique very shallow ridges, spaces between them tawny ; rostrum tawny with a black tip ; abdomen luteous, pectus and legs yellow : tips of the spines and feet pitchy : tegmina ferruginous, thickly covered with tawny

down, with two oblique whitish stripes on the fore-border near the tip where there is a black dot; first stripe broad, second very small, a black dot on the hind-border near the tip and a few whitish streaks along the veins: wings colourless, veins black, tawny towards the base. Body long $6\frac{1}{2}$: exp. teg. 15 millims.

Reported from N. Bengal.

45. CLOVIA NEBULOSA, Fabricius.

Cercopis nebulosa, Fabr., Syst. Ent. iv. p. 50, no. 14, (1794): Syst. Rhyn. p. 94, (1803).

Clovioa nebulosa, Stål, Hem. Fabr. ii. p. 16, (1869).

Very pale yellowish-grey: two small median black spots on the head: tegmina obscurely fuscous, a very oblique anterior band, a somewhat large median spot varied with fuscous at the commissure, an obliquely transverse spot behind the middle of the costal margin and a minute costal spot towards the apex, yellowish grey: two narrow median stripes abbreviated before the middle and a lateral subtriangular spot on the thorax also lateral limbus of scutellum, fuscous. Long with tegmina, 10; breadth of pronotum 3 millims.

Reported from E. India.

Genus CARYSTUS, Stål.

Berlin Ent. Zeitschr., vi. p. 303 (1862): Hem. Afric. iv. p. 69, 81 (1866).

Head as broad or almost as broad as the thorax, obtusely angulated; lobes of the vertex transversely impressed at the apex or furnished with a transverse ridge near the apex; frons slightly convex: rostrum short: thorax quadrangular or sexangular, in the latter case anterior lateral margins short: scutellum long, much longer than broad: tegmina membranous, pellucid, margined at the apex, obliquely roundly subtruncate at the apex: posterior tibiæ bispinose, upper spine sometimes very minute.

46. CARYSTUS VIRIDICANS, Stål.

Ptyelus viridicans, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 251 (1854): Freg. Eng. resa, Hem. p. 286 (1859).

Carystus viridicans, Spangberg, Ofvers. Kong. Vet. Aka. Förh. No. 9, p. 13 (1877).

Weakly olive-green, below with the feet still weaker: vertex and thorax anteriorly weakly rufous-testaceous: tegmina olive-yellow, hyaline: spines of the posterior feet black at the apex.

Body long 5: breadth of pronotum 2 millims. Reported from Java, Malacca, Singapore, Tenasserim (?).

Subfamily MACHÆROTINA, Stål.

Machærotida, Stål, Hem. Afric. iv. p. 55 (1866) : *Machærotina*, Stål, Ofvers. Kong. Vet. Aka. Förh. p. 727 (1870).

Anterior margin of thorax round or angular, eyes usually transverse : scutellum much elevated, compressed posteriorly, furnished with a long apical spine.

Genus MACHÆROTA, Burmeister.

Handb. Ent. ii. (i) p. 128 (1835).

Head small, frons tumid, confluent with the vertex, furrowed in the middle, elevated at the posterior margin, bearing the two ocelli which are approximate : basal joints of antennæ large, terminal setæ long, fine, curved : pronotum septangular, arcuate : scutellum larger, produced backwards with a median longitudinal groove which is continued into a long, pointed, acute upwardly, curved downwardly, sabre-like process : tegmina hyaline, with seven cells at the apex and a large middle cell surrounded by a forked vein : legs simple, hinder tibiæ and two first joints of the tarsi with a circlet of spinules.

47. MACHÆROTA ENSIFERA, Burmeister.

Machærota ensifera, Burm. Handb. ii. i. p. 128 (1835) : Walker, List Hom. B. M. iii, p. 729 (1851) : Stål, Ofvers. Kong. Vet. Aka. Förh. p. 727 (1870) : Signoret, A. S. E. F. (5 Sér.), ix, p. xlviii. (1879).

Light yellow with the second and third segments above, the median part of the frons, a space on each side of the metanotum and the origin of the process, black : tegmina and wings hyaline, the base of the tegmina and the claval portion of the wings, fuscous : tegmina with five apical cells of which three lie towards the margin ; above these, which gradually diminish in size, is a row of hyaline dots, on the margin itself : there are five brownish streaks on the prothorax of which the two median lateral ones are continued on the metanotum. Long 4 millims. ♂.

Reported from Philippines, Silhat.

48. MACHÆROTA SPANGBERGI, Signoret.

Machærota spangbergi, Signoret, A. S. E. F. (5 Sér.), ix, p. xlviii. (1879).

Yellowish brown ; the median part of the frons, the tip of the abdomen above and the genital organs, black ; feet brownish, posterior tibiæ yellow with the tips black. Differs from *M. ensifera* in having the frontal grooves black and the tegmina longer and less rounded at the tip. Long 4 millims. ♀.

Reported from Silhat.

49. *MACHÆROTA PUNCTULATA*, Signoret.

Machærota punctulata, Signoret, A. S. E. F. (5 Sér.), ix. p. xlix. (1879).

Brownish yellow, with the middle of the frons, the abdomen above (except the base), the feet (except the posterior tibiæ), and the frontal grooves, black; several transverse black spots on the thorax which is very finely punctured: metanotum brownish with two yellow, lateral, basal spots, the tip and the process blackish: tegmina elongate, five-celled and above the marginal two to three others smaller, very distinct: the hyaline nervures are spotted with several brown dots. Long 4 millims. ♀.

Reported from Silhat.

NOTE. *Cosmopsaltria abdulla*, Distant, noticed as No. 57 at page 226 of the Journal for 1884 is the same as *Cosmopsaltria spinosa*, Fabricius, No. 59. The Indian Museum possesses a specimen of *Cosmoscarta siamensis*, Butler, but the locality being uncertain, it has not been entered here.



III.—*On Observations of the Solar Thermometer at Lucknow.*—By
S. A. HILL, B. Sc., A. R. S. M., Meteorological Reporter North-
Western Provinces and Oudh.

[Received 23rd March 1885;—Read 6th May 1885.]

In the volume of this Journal for 1883,* I have discussed some observations of solar radiation made at Allahabad with the ordinary black-bulb maximum thermometer *in vacuo*. The conclusions drawn from these were that the absorbing power of the atmosphere is dependent upon the tension of aqueous vapour and the quantity of dust suspended in the air, pure dry air being very diathermanous; and that, when allowance is made for the variations of aqueous vapour, the mean results for the heating power of the sun during the years 1876—1882 exhibit a very uniform and gradual variation, culminating in 1878 and gradually decreasing afterwards, therefore presumably having an inverse relation to the number of spots on the sun's surface. The resulting variation is so regular in its character that, irrespective of its pointing to a conclusion regarding the sun's heat which is the reverse of that gene-

* Vol. li. Part ii.

rally held by solar physicists, I have always looked upon it as doubtful, and probably due in part to some fortuitous combination of errors. I therefore intend on some future occasion, possibly after the end of the present year, when the position of the thermometer at Allahabad will be changed, to go over the figures again, taking a longer series of observations and making allowance for a cause of variation from month to month, namely, the elliptic form of the earth's orbit, which was neglected in the paper referred to. Meanwhile, I wish to lay before the Society the results of some other observations bearing on the same question, which tend to confirm the conclusions arrived at in my previous paper. To the method by which these results are attained, less exception can be taken, because they are in every case derived from several observations made on the same day under different degrees of obliquity of incidence, instead of upon the single record of a self-registering instrument.

Shortly after hourly observations on four days in each month were commenced at Lucknow, it was discovered that the solar thermometer in use at that station had ceased to be self-registering. A new instrument was therefore brought into use on ordinary days, but the old one was retained for the hourly observations. The records of all such observations of this instrument since the middle of the year 1876 have been filed, but for the purposes of the present paper I have used only those of the eight years 1877—1884 inclusive. At Agra, similar observations of a non-registering solar thermometer have been made for some years on hourly observation days, but, owing to a change of instrument, the register for the years 1877—1884 is broken. For this reason, and because the observatory at Agra is situated in the midst of the city, I have not thought it worth while to reduce the registers of that station, though they seem to confirm in a general way the results obtained from Lucknow.

Those parts of the Lucknow records which have been used for the purposes of the present paper are printed in Table I. The figures represent for each hour of observation the difference between the temperature of the black-bulb thermometer in the sunshine and the simultaneous temperature in the shade. Only those hours are given at which the sky was either quite free from cloud or at which the cloud proportion did not exceed 2-10ths of the expanse. In the months of July and August, very few clear days, thus defined, occur; consequently these months have been left out in drawing up the tables. For every other month in the eight years, except September 1878 and June 1880, there are some observations available.

TABLE I.—*Excess Temperatures of Insolation on clear, or nearly clear, days at Lucknow.*

	Hours of observation, Mean Time.								
	8	9	10	11	12	13	14	15	16
January, 1877...7th	23·9	43·3	51·0	52·1	56·1	...	...	42·4	29·1
14th	41·1	51·0	59·5	...	...	...	...	...	...
21st	41·5	52·5	57·5	60·7	57·8	56·6	53·6	50·1	40·1
28th	...	...	...	...	...	...	...	...	...
February.....7th	...	...	...	...	...	...	...	...	...
14th	42·0	53·8	55·0	57·3	62·8	57·7	55·3	46·4	42·1
21st	...	...	...	...	...	...	...	...	...
28th	44·0	54·1	58·8	59·4	59·6	58·9	55·8	51·1	45·4
March.....7th	42·0	54·1	58·6	59·1	58·9	58·1	55·1	47·9	39·1
14th	38·1	52·1	58·1	56·1	54·6	54·1	52·6	...	...
21st	...	...	...	...	...	...	...	...	...
28th	...	...	...	...	...	56·1	52·9	49·6	41·9
April .....7th	...	...	...	...	...	...	...	...	...
14th	47·1	53·6	57·6	58·1	57·1	55·0	52·8	...	...
21st	48·1	53·1	56·1	56·5	57·0	55·5	54·0	50·7	44·5
28th	...	...	...	...	...	...	...	...	...
May .....7th	...	...	...	...	...	...	...	52·1	44·9
14th	...	55·8	55·8	57·0	56·0	57·0	54·5	49·5	42·0
21st	47·3	52·0	55·0	57·7	54·0	...	...	49·5	38·3
28th	40·3	48·3	53·0	57·0	58·0	54·8	55·0	50·0	41·8
June.....7th	...	...	...	...	...	...	...	...	...
14th	42·9	49·5	56·0	55·5	56·7	55·7	55·5	49·0	36·8
21st	38·8	50·0	55·0	...	...	...	...	41·0	35·0
28th	...	...	...	...	...	...	...	...	...
September.....7th	...	45·9	53·1	...	57·3	...	...	...	...
14th	38·4	47·9	50·0	56·5	56·0	...	...	...	...
21st	40·9	47·8	49·3	51·8	53·8	...	...	...	...
28th	37·1	45·1	46·5	53·3	54·0	...	51·0	47·0	35·5
October.....7th	...	...	...	...	...	...	...	...	...
14th	43·6	48·9	53·6	55·4	56·1	54·4	50·3	45·1	35·1
21st	38·1	43·6	46·4	48·1	50·1	48·6	...	...	32·1
28th	40·1	46·4	54·6	56·4	56·4	52·6	48·6	41·6	29·6
November .....7th	...	...	...	...	...	...	...	...	...
14th	35·7	49·4	...	58·1	58·1	55·6	54·1	47·4	18·6
21st	...	44·1	51·4	56·4	57·9	57·6	50·4	44·3	20·3
28th	...	...	...	...	...	...	...	...	...
December .....7th	...	...	...	...	...	...	...	...	...
14th	41·5	52·3	56·3	54·5	53·5	52·0	48·5	44·7	11·0
21st	39·3	47·0	...	...	...	48·0	40·8	32·8	12·3
28th	...	...	...	...	...	...	...	...	...

[illegible]

[illegible]

		Hours of observation, Mean Time.								
		8	9	10	11	12	13	14	15	16
January, 1880...	7th	43·3	53·0	57·9	49·5	49·4	49·6	43·1	37·6	25·6
	14th	36·6	50·7	54·8	49·7	50·6	47·6	43·6	37·8	32·0
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	...	...	...	...	...	...	...
February.....	7th	42·0	50·5	57·5	51·0	51·9	50·4	47·6	43·1	34·6
	14th	...	...	...	...	...	...	...	...	...
	21st	43·8	54·7	59·9	56·3	54·6	52·6	50·4	47·8	41·8
	28th	38·1	57·4	61·0	56·6	54·5	52·0	49·1	44·1	37·6
March.....	7th	28·0	47·6	55·4	53·6	53·9	49·1	46·8	47·8	31·9
	14th	33·6	49·4	58·1	56·0	54·8	52·8	49·8	44·8	34·8
	21st	39·6	47·0	52·2	49·6	55·8	53·8	46·8	41·8	39·3
	28th	38·6	47·6	54·1	55·8	56·6	53·8	52·0	51·3	43·3
April	7th	43·6	50·6	54·1	...	...	...	...	...	40·8
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	...	...	53·0	50·8	52·8	47·8	40·6
May.....	7th	45·6	53·1	56·6	56·8	55·6	54·1	52·2	48·3	42·8
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	38·5	49·3	51·8	52·8	52·8	54·8	54·8	51·2	42·8
June.....	7th	...	...	...	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	...	...	...	...	...	...	...
September	7th	...	...	...	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	45·1	50·0	56·1	...	...	...	...	...	...
	28th	...	...	...	...	...	...	...	...	...
October	7th	28·6	47·1	54·1	59·1	56·0	54·2	45·8	42·9	38·6
	14th	41·4	49·9	57·6	59·6	58·8	58·6	55·8	52·3	...
	21st	44·6	52·1	52·6	56·4	58·7	56·4	54·3	45·6	29·8
	28th	46·6	53·6	62·6	62·9	66·6	62·7	59·7	51·6	...
November	7th	39·6	51·1	54·1	57·1	46·6	45·6	...	...	...
	14th	42·0	50·5	53·6	53·6	46·1	45·6	46·6	39·1	28·6
	21st	...	...	...	...	...	...	...	...	...
	28th	...	52·8	56·8	53·1	50·8	50·1	41·9	36·4	23·2
December	7th	35·7	48·0	55·6	...	...	55·6	54·1	...	...
	14th	36·0	46·5	...	...	56·6	47·0	...	34·6	25·6
	21st	...	...	...	...	52·0	47·5	43·6	35·6	27·5
	28th	36·6	46·3	65·1	56·1	49·6	...	...	...	27·1

		Hours of observation, Mean Time.								
		8	9	10	11	12	13	14	15	16
January, 1881...	7th	...	...	...	49·8	53·5	56·7	49·9	46·6	28·0
	14th	38·6	50·8	54·0	52·5	49·9	50·1	42·6	38·6	29·1
	21st	34·6	51·5	59·0	57·0	54·1	52·9	48·8	41·1	31·9
	28th	54·3	60·8	64·3	70·7	74·7	77·2	...	...	...
February	7th	37·5	52·5	55·5	53·6	54·6	54·6	53·1	47·6	39·6
	14th	33·5	52·0	52·6	56·1	55·1	53·6	52·1	46·7	...
	21st	...	...	...	...	...	...	...	...	...
	28th	29·5	52·6	57·1	57·1	57·6	...	...	...	...
March.....	7th	...	...	...	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	45·5	55·8	59·1	...	...	...	...	...	...
	28th	44·5	51·6	57·1	...	...	...	...	...	...
April	7th	...	...	...	...	...	...	...	...	...
	14th	45·6	53·9	56·9	54·8	55·3	54·8	52·8	...	58·3
	21st	40·7	48·0	55·1	56·1	55·9	55·3	51·9	...	43·8
	28th	46·4	47·6	57·6	58·3	55·8	52·6	50·3	45·3	33·8
May.....	7th	40·1	47·6	52·8	53·8	54·3	53·3	49·8	44·8	36·2
	14th	...	...	...	...	...	...	...	...	...
	21st	37·5	47·8	52·3	53·6	55·3	54·6	53·6	...	...
	28th	41·1	48·3	53·3	57·6	54·6	51·8	...	...	...
June	7th	32·3	39·3	42·3	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	...	...	...	...	...	...	...
September.....	7th	...	...	...	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	41·8	52·8	56·8	54·4	53·8	53·3	...	...	42·3
October	7th	...	...	...	...	...	...	...	...	...
	14th	42·6	51·7	54·6	54·9	54·3	51·3	47·3	40·3	30·8
	21st	48·6	52·6	53·8	51·8	53·3	51·3	43·6	35·3	29·1
	28th	...	...	...	51·9	53·9	49·4	49·1	44·9	26·5
November	7th	...	...	...	...	...	48·1	45·1	38·6	22·1
	14th	47·3	54·1	58·6	52·9	53·6	50·6	43·8	40·9	19·6
	21st	42·9	51·3	55·6	56·6	54·1	49·6	43·7	38·1	26·6
	28th	42·8	49·7	54·1	47·1	45·6	40·9	36·1	34·1	21·6
December	7th	35·5	48·8	52·0	52·4	52·9	47·9	43·4	31·6	21·4
	14th	45·0	51·5	53·5	50·4	46·6	42·6	43·4	30·1	17·6
	21st	29·8	50·0	55·5	50·1	47·6	43·6	32·1	27·6	17·6
	28th	38·8	51·3	54·5	55·9	54·1	49·8	43·1	34·6	23·1

	Hours of observation, Mean Time.								
	8	9	10	11	12	13	14	15	16
January, 1882...7th	33·5	49·8	54·5	55·0	53·7	50·6	48·1	44·1	32·1
14th	35·3	38·2	52·5	55·5	55·5	51·0	45·9	41·4	...
21st	29·5	42·3	51·5	54·5	55·8	51·6	47·1	38·6	32·4
28th	42·5	44·5	55·6	57·6	...	49·4	...	38·4	33·1
February 7th	45·5	52·5	59·4	61·1	59·1	56·9	50·6	42·6	33·4
14th	...	...	...	...	...	49·6	44·4	39·9	28·4
21st	45·5	56·7	62·5	60·6	61·6	59·9	57·4	53·6	44·6
28th	31·5	48·1	61·1	56·6	56·6	55·1	52·1	46·9	37·6
March 7th	39·3	51·6	57·1	55·1	54·8	50·8	...	...	...
14th	...	...	...	...	...	...	...	...	...
21st	50·6	53·4	58·6	59·3	56·8	54·3	51·8	42·6	23·3
28th	40·6	48·8	55·6	55·9	57·8	58·8	53·8	47·3	39·6
April 7th	...	...	...	...	...	...	...	...	...
14th	45·6	53·6	56·8	59·8	59·0	54·6	52·8	48·3	41·3
21st	...	...	...	...	...	...	...	...	...
28th	44·2	53·0	58·3	59·8	56·6	51·8	49·3	46·8	40·3
May 7th	51·6	54·9	56·6	...	...	...	...	...	...
14th	...	...	...	...	...	...	...	...	...
21st	45·8	54·8	56·3	59·8	55·3	51·8	46·3	41·8	39·8
28th	...	...	...	...	...	...	...	...	...
June 7th	...	...	...	...	...	...	...	...	...
14th	...	...	...	...	...	...	...	...	...
21st	42·6	47·4	...	...	...	...	49·8	43·3	...
28th	...	...	...	...	...	...	...	...	...
September..... 7th	35·6	48·6	53·1	...	...	...	...	...	...
14th	...	...	...	...	...	...	...	...	...
21st	...	...	...	...	...	...	...	...	...
28th	52·1	52·4	52·1	47·8	50·8	50·8	46·3	40·8	30·5
October 7th	...	...	...	...	...	...	...	...	...
14th	37·6	46·6	51·1	51·1	49·8	44·3	40·3	32·5	26·8
21st	46·6	51·0	53·6	54·6	48·6	46·3	41·3	35·8	23·8
28th	39·9	49·6	50·4	49·9	48·1	42·6	39·1	36·6	18·6
November 7th	45·2	48·1	50·4	50·6	47·1	41·9	38·1	30·9	13·6
14th	40·2	45·1	51·9	50·3	45·6	41·6	37·6	30·9	15·1
21st	37·5	50·5	54·1	51·4	46·6	42·1	36·1	26·1	12·1
28th	...	...	...	...	...	...	...	...	...
December 7th	31·2	46·5	51·1	51·6	49·6	43·1	37·1	27·6	18·1
14th	35·3	45·5	48·6	47·6	44·9	41·1	36·1	26·1	18·6
21st	...	...	...	...	...	...	...	...	...
28th	43·5	55·5	55·5	54·6	51·1	45·6	37·6	27·1	15·6

		Hours of observation, Mean Time.								
		8	9	10	11	12	13	14	15	16
January, 1883...	7th	27.8	40.8	47.0	48.4	...	...	...	...	...
	14th	34.5	49.5	52.5	52.1	50.6	46.4	38.6	31.6	22.6
	21st	...	...	...	...	...	...	...	...	...
	28th	31.5	47.5	54.0	54.5	50.5	48.5	41.5	35.0	28.0
February	7th	41.1	50.8	55.0	56.0	54.5	48.6	43.6	39.4	31.6
	14th	36.5	52.0	55.0	55.6	54.1	50.0	46.9	36.6	32.6
	21st	37.5	53.5	54.4	54.9	53.1	50.1	46.1	...	...
	28th	...	...	...	...	...	...	...	...	...
March.....	7th	...	...	...	...	...	...	...	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	34.6	46.6	55.6	55.6	56.1	52.1	48.9	41.6	...
	28th	40.6	50.6	52.6	55.3	54.1	50.8	46.8	...	...
April	7th	43.6	53.6	55.1	56.3	54.3	50.8	46.8	41.3	39.8
	14th	...	...	...	...	...	...	...	...	...
	21st	48.2	53.8	56.1	55.8	55.6	54.3	48.1	44.3	37.8
	28th	37.6	49.6	53.6	55.6	55.8	...	48.8	41.8	33.1
May.....	7th	43.8	50.8	54.8	55.8	54.8	52.3	47.8	45.3	36.8
	14th	36.6	54.8	56.8	54.8	53.1	50.5	49.5	46.3	...
	21st	30.6	43.6	44.8	48.8	55.6	56.3	49.8	44.8	31.8
	28th	...	...	...	...	...	...	...	...	...
June	7th	36.1	50.8	53.8	55.6	52.8	49.8	46.3	46.8	36.8
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	...	...	...	...	...	...	...
September	7th	44.1	48.6	...	...	54.8	51.8	47.8	...	...
	14th	...	...	...	...	...	...	...	...	...
	21st	...	...	...	...	...	...	...	...	...
	28th	...	...	52.9	52.0	51.3	47.8	44.3	38.8	30.8
October	7th	...	...	...	...	...	...	...	...	...
	14th	43.1	46.9	48.6	50.6	52.8	53.8	46.8	35.8	21.6
	21st	50.6	53.8	53.6	53.4	53.1	55.1	48.4	45.6	28.6
	28th	43.5	48.1	51.1	51.6	54.1	54.6	46.1	41.4	22.6
November	7th	...	...	...	...	...	...	...	...	...
	14th	29.6	37.1	42.6	48.6	52.6	...	...	...	...
	21st	32.5	41.5	53.5	52.1	56.6	58.6	...	...	...
	28th	49.5	50.5	47.6	51.6	50.6	45.1	...	...	...
December	7th	...	40.5	40.5	44.4	45.1	45.6	36.1	22.6	...
	14th	...	...	47.5	48.1	48.6	44.6	35.6	28.6	...
	21st	...	52.0	53.5	62.0	60.6	47.6	35.6	22.1	...
	28th	...	36.5	47.5	58.5	56.1	53.6	48.6	40.6	...

The differences between the numbers given in the table depend primarily upon variations in the sun's incident heat and in the proportion of this which is absorbed before reaching the instrument, the latter being dependent upon the composition of the atmosphere and the obliquity of the rays. Minor causes of variation depend upon the instrument itself and the nature of its surroundings, and upon the reflexion of heat from cloud, haze, or dust particles in the air; the instrument being designed to receive rays coming from all directions and not parallel rays only.

As regards the instrument itself, if its thermal capacity be large, it will be sluggish in responding to any change in the incident radiation. This will cause the incident heat in the afternoon to appear greater than in the forenoon. The Lucknow observations are not appreciably affected with any error of this sort, since the thermometer is a small one with a bulb not much larger than a pea and a tube so fine in bore as to make it easy to estimate tenths of a degree Fahrenheit in reading it. It would, therefore, respond almost instantaneously to any change in the incident radiation, were it not that owing to friction in the narrow tube the mercurial column seems to rise and fall by slight jumps and starts. Observations made at equal hour angles before and after noon may be expected, however, when combined, to eliminate any error due to the sluggishness or *per saltum* action of the thermometer.

The effect of changes in the nature of the ground-surface beneath the instrument and in other objects in the vicinity cannot be readily eliminated. They have been reduced to a minimum, however, by placing the thermometer in the centre of an open space on a stand 4 feet high.

The antecedent probability that the variations in the absorptive power of the atmosphere must be very considerable is great, for, even if we have nothing else to go upon but the observations in Table I., these indicate that the total absorption is almost as great in June, when the incident rays at noon are nearly vertical, as in December, when the sun rises only 40° above the horizon. To estimate the absorbing power, it is necessary to make some assumption regarding the manner in which it varies with the thickness of the atmosphere traversed by the rays. The only simple formula yet proposed which gives results in fair accord with observations made on a clear day is that of Ponillet. This formula, it is true, applies in strictness only to radiation of one definite kind, because the atmospheric absorption is selective; and Langley* has shown, by a hypothetical example, that the approximate constancy of absorption indicated by applying the formula to observations made on the same day at the most various angles of obliquity may co-exist with an error of

* Zeitsch. d. Oest. Gesellsch. für Met., B. xx, S. 86.

nearly 50 per cent. in the deduced coefficient. Nevertheless, since it is impossible in practice to apply the method of prismatic analysis to all the very numerous actinometric observations which are required to prove the constancy or otherwise of the sun's radiation, and since the results of such an analysis must necessarily be vitiated to some extent by the selective absorption of the prism, some simple formula must be used and that of Ponillet is the best hitherto suggested. Even if the atmospheric absorption and consequently the radiation before it enters the atmosphere, as determined by this formula, be both much less than they ought to be, their variations from day to day or from month to month deduced by means of the formula must be in the same direction as they are in reality.

Ponillet's formula is $r = Ap^e$, where r is the observed heating effect, A the effect undiminished by atmospheric absorption, p the diathermancy or transmission coefficient, and e the thickness of the atmosphere traversed by the rays. Table II. gives the values of e which have been employed in reducing the Lucknow observations. They have been calculated to a first approximation only, that is to say, they are equal to the secants of the sun's zenith distance at the hours of observation.

TABLE II.—*Atmospheric Thickness at Lucknow, Latitude 26° 50' N.*

Date.	Hours of observation, Mean Time.								
	8	9	10	11	12	13	14	15	16
January 7th	4.44	2.52	1.89	1.62	1.53	1.59	1.81	2.33	3.86
14th	4.38	2.49	1.85	1.58	1.50	1.54	1.75	2.23	3.38
21st	4.29	2.43	1.81	1.55	1.46	1.50	1.69	2.13	3.23
28th	4.15	2.34	1.75	1.49	1.41	1.44	1.62	2.01	3.06
February 7th	3.79	2.21	1.62	1.43	1.35	1.38	1.54	1.89	2.80
14th	3.55	2.12	1.61	1.38	1.30	1.33	1.47	1.81	2.61
21st	3.25	2.00	1.54	1.33	1.25	1.28	1.42	1.74	2.48
28th	2.99	1.89	1.47	1.27	1.20	1.23	1.36	1.66	2.34
March..... 7th	2.71	1.78	1.40	1.23	1.17	1.20	1.33	1.61	2.25
14th	2.51	1.69	1.34	1.19	1.13	1.17	1.29	1.57	2.17
21st	2.34	1.63	1.31	1.16	1.10	1.15	1.27	1.55	2.11
28th	2.19	1.55	1.26	1.12	1.08	1.11	1.23	1.49	2.04
April 7th	2.03	1.47	1.21	1.09	1.05	1.09	1.21	1.45	1.97
14th	1.93	1.42	1.18	1.07	1.04	1.07	1.19	1.43	1.93
21st	1.86	1.39	1.16	1.06	1.03	1.06	1.17	1.41	1.89
28th	1.80	1.36	1.14	1.04	1.01	1.05	1.16	1.39	1.86
May 7th	1.74	1.33	1.13	1.03	1.01	1.04	1.15	1.38	1.82
14th	1.71	1.32	1.12	1.03	1.00	1.04	1.15	1.36	1.79
21st	1.69	1.31	1.12	1.03	1.00	1.04	1.14	1.35	1.77
28th	1.69	1.31	1.12	1.03	1.00	1.03	1.13	1.34	1.74

Date.	Hours of observation, Mean Time.								
	8	9	10	11	12	13	14	15	16
June 7th	1·69	1·31	1·12	1·03	1·00	1·03	1·13	1·32	1·70
14th	1·70	1·32	1·12	1·03	1·00	1·03	1·12	1·31	1·69
21st	1·71	1·33	1·13	1·03	1·00	1·03	1·12	1·31	1·68
28th	1·72	1·33	1·13	1·03	1·00	1·03	1·12	1·30	1·66
September..... 7th	2·02	1·47	1·22	1·11	1·06	1·11	1·23	1·50	2·06
14th	2·06	1·50	1·24	1·13	1·08	1·13	1·27	1·56	2·20
21st	2·11	1·55	1·27	1·15	1·10	1·16	1·31	1·63	2·34
28th	2·17	1·56	1·29	1·17	1·13	1·20	1·36	1·71	2·53
October 7th	2·32	1·64	1·36	1·23	1·19	1·26	1·45	1·85	2·86
14th	2·37	1·68	1·38	1·25	1·22	1·30	1·49	1·92	3·04
21st	2·48	1·63	1·43	1·29	1·26	1·34	1·56	2·02	3·31
28th	2·60	1·80	1·47	1·33	1·30	1·39	1·62	2·13	3·60
November 7th	2·84	1·92	1·56	1·40	1·37	1·47	1·72	2·30	4·06
14th	3·04	2·01	1·62	1·46	1·42	1·52	1·79	2·40	4·33
21st	3·23	2·04	1·68	1·50	1·46	1·56	1·84	2·48	4·53
28th	3·45	2·19	1·73	1·54	1·50	1·59	1·88	2·53	4·69
December 7th	3·81	2·32	1·81	1·59	1·54	1·63	1·91	2·57	4·73
14th	4·06	2·40	1·85	1·62	1·56	1·64	1·92	2·55	4·64
21st	4·30	2·47	1·88	1·63	1·56	1·64	1·90	2·50	4·42
28th	4·45	2·51	1·89	1·63	1·56	1·62	1·87	2·44	4·19

In making reductions of actinometric observations it soon becomes evident that the atmospheric absorption varies not only from day to day, but frequently from hour to hour. In nearly every month it seems to be greater at Lucknow in the afternoons than in the forenoons, as might be anticipated from the disturbances caused by diurnal heating, evaporation, and the quantity of dust stirred up in dry weather by the diurnal winds. Besides this general and regular increase from forenoon to afternoon, there are numerous irregular changes from hour to hour, which render it very difficult to estimate fairly the true absorbing power and the incident heat. For example, if the absorbing power happens to be greater about noon than in the morning or evening, the curve representing the variation of the observed heating effect will be flatter than it should be, and the deduced value of the incident radiation will be too low; whereas, if the absorbing power be least about midday, the deduced solar constant will be too high.

To reduce errors of this kind to a minimum, I have, wherever the series of observations for the several days of a month were complete or nearly complete, taken the mean for each hour, and then deduced the constants A and p of the formula from these mean values. In other

cases, I have made a graphic representation of the logarithms of the observed radiation on a scale the abscissæ of which represented the values of ϵ ; and any observation which fell wide of the straight line indicated by the formula has been rejected.

Proceeding in this way, I have arrived at the following probable mean values of the solar radiation undiminished by absorption, and of the absorbing power of the atmosphere for vertical rays. The latter are the values of $(1-p)$ when p is defined as above.

TABLE III.—*Mean Values of the Constant of Solar Radiation in Degrees of the Black-bulb Thermometer.*

Year.	Jan.	Feb.	March	April.	May	June.	Sept.	Oct.	Nov.	Dec.	Mean of	
											all months.	Eight months.*
1877 ...	76.1	78.2	72.7	73.3	80.4	86.6	77.6	79.8	91.1	85.5	80.1	79.6
1878 ...	78.5	90.8	88.3	85.0	92.4	95.8	?	85.4	84.6	79.2	86.7	85.5
1879 ...	76.7	77.6	80.1	92.7	99.2	85.9	77.1	74.6	71.2	69.4	80.4	80.2
1880 ...	73.2	78.6	83.3	75.9	80.6	?	80.7	79.1	68.3	70.7	76.7	76.2
1881 ...	72.4	74.0	78.1	72.2	85.7	77.5	73.9	73.6	67.6	71.7	74.7	74.4
1882 ...	75.2	79.5	78.8	81.9	78.8	73.4	70.6	68.8	67.5	71.3	74.6	75.2
1883 ...	74.4	73.0	76.6	80.9	77.8	79.7	74.9	74.9	76.1	75.7	76.4	76.2
1884 ...	74.7	74.0	74.6	82.5	82.0	77.6	77.6	73.8	78.7	76.4	77.2	77.1
Mean	75.2	78.2	79.0	80.6	84.6	82.4	76.1	76.2	75.6	75.0	78.3	78.0

TABLE IV.—*Coefficients of Atmospheric Absorption for Vertical Rays.*

Year.	Jan.	Feb.	March	April.	May.	June.	Sept.	Oct.	Nov.	Dec.
1877 .....	.175	.194	.188	.216	.294	.342	.272	.269	.268	.255
1878 .....	.260	.264	.269	.266	.354	.407	?	.274	.251	.230
1879 .....	.212	.199	.226	.324	.390	.358	.312	.232	.191	.201
1880 .....	.179	.211	.317	.265	.306	?	.256	.259	.187	.160
1881 .....	.201	.194	.230	.255	.360	.377	.213	.233	.175	.205
1882 .....	.199	.218	.258	.295	.302	.311	.231	.240	.228	.224
1883 .....	.222	.224	.278	.316	.306	.319	.277	.235	.223	.216
1884 .....	.241	.243	.245	.251	.277	.324	.272	.368	.274	.267
Mean	.211	.218	.251	.279	.326	.333	.262	.251	.225	.220

* June and September being left out.

From Table III., it appears that the variation of the solar heat from year to year has been similar to that deduced from the Allahabad observations, while the range indicated is even greater. The highest annual mean is that for 1878, when the sun spots were at a minimum, and the lowest, that for 1881 or 1882, when the spots were probably at a maximum.

Such a very distinct variation in the sun spot period must, I think, be the effect of a real variation in the emission of solar energy, but the great range of the observed inequality is probably due in part to other causes. It is evident from the means at the foot of Table II. that all the terrestrial causes of variation have not been eliminated, for, whilst these means are nearly constant for the months of September, October, November, December, and January, they are much more variable and considerably greater in the dry hot months of the year. If the excess temperature of the solar thermometer above that of the air were a true measure of the solar radiation, it should, when the observations are corrected for atmospheric absorption, give somewhat lower results for May and June than for December and January, on account of the greater distance of the sun in the former months. The opposite variation which is observed must be due to heat reflected from the bare hot ground and from the dust particles suspended in the air.

Since the bareness and hardness of the ground-surface under the instrument and the quantity of dust in the air are due to the same cause, and increase *pari passu*; it is, perhaps, justifiable to assume that the increase of the observed effect which is due to reflexion may be taken proportional to the quantity of dust. That is to say, we may put

$A = \frac{S}{r^2} (1 + ad)$. In this formula A represents the mean value for any month at the foot of Table III.; S , the value this mean would have if the ground were moist and grassy, the air free from dust, and the earth at its mean distance from the sun; r the radius vector of the earth at the middle of the month; d the proportion of dust in the air; and a a coefficient which remains to be determined. The proportionate numbers for dust which I have assumed are:—

Jan. Feb. Mar. Apl. May June Sept. Oct. Nov. Dec.

8 5 7 9 10 6 0 0 1 2

These differ somewhat from those already adopted for Allahabad, but, perhaps, represent the facts more justly. By means of the formula, with these values for d , we find:—

$$S = 73.0^\circ$$

$$a = .0157$$

In the month of May, therefore, the observed radiation is 15 or 16 per

cent. greater than it would be if the ground were grassy and the air free from dust, other things being the same.

It follows from this that in a dry year the solar thermometer will give higher indications than in a damp one when due allowance is made for variations in atmospheric absorption. There can be little doubt that part of the great excess of the results for the latter half of 1877, the whole of 1878, and the first half of 1879, above those for subsequent years, is due to this cause; which is still better illustrated by comparing the months of March, April, and May, 1877, with the same months of 1879. In the former year the spring months were unusually showery, and, in consequence of this, the ground-surface was covered with grass, whilst in 1879 no rain fell and the ground was quite bare and dusty.

The conclusion to be drawn from this investigation seems to be that, while the results indicate a rather strong presumption in favour of the hypothesis that the emission of solar heat varies inversely with the number of sun spots, the hypothesis can only be definitely proved by observations of some kind of actinometer which is protected from reflexion and receives direct solar rays only. Probably, the form of instrument which will be found most useful is a thermopile turned by clock-work so as to face the sun and attached to a reflecting galvanometer by means of which the heating effect can be photographically recorded.

The absorption coefficients given in Table IV. are least in the cold weather months and greatest in the hot season and the rains. Since these coefficients are dependent upon the constitution of the atmosphere, it may be assumed, as it has been in my previous paper, that the constant p of Ponillet's formula is the product of three factors, α^b , β^f , and γ^d , where b is the barometric pressure, f the pressure of vapour, and d the proportionate number for dust. In strictness, b should stand for the pressure of the dry air only, but as the aqueous vapour thins out about three times as fast on ascending as it would do on the hypothesis of an independent vapour-atmosphere the pressure of the dry air is not $(b-f)$, as some suppose, but something very little less than b .

The mean values of the barometric pressure and tension of vapour observed at noon in the days given in Table I., are the following:—

	Pressure.	Vapour Tension.
January	29 + .714 in.	.304 in.
February	.660	.281
March	.529	.374
April	.415	.406
May	.293	.568
June	.171	.674

	Pressure.	Vapour Tension.
September	·341 in.	·779 in.
October	·546	·464
November	·669	·335
December	·709	·268

By inserting these figures and those for dust above given in the formula, $\log p = b \log a + f \log \beta + d \log \gamma$, it is found that the most probable values of the constants are :—

$$a = \cdot 99518$$

$$\beta = \cdot 78091$$

$$\gamma = \cdot 98924$$

These results, while confirming those already arrived at, indicate that the absorption of solar radiation by dry air is greater than I have hitherto supposed, though not nearly so great as the absorption by water vapour.

IV.—*List of the Butterflies of Calcutta and its Neighbourhood, with Notes on Habits, Food-plants, &c.*—By LIONEL DE NICEVILLE.

[Received 15th October ;—Read 3rd December, 1884.]

In the 'Entomologist's Monthly Magazine,' 1882 vol. XIX, p. 33, there is a paper by Mr. G. A. J. Rothney, entitled, "A list of the Butterflies captured in Barrackpore Park during the months of September, 1880, to August, 1881." In this list, however, only 98 species are mentioned, which probably all occur in Calcutta, the two places being but 14 miles apart, and both situated on the low-lying deltaic banks of the Hughli. I have accordingly included all those of Mr. Rothney's species which I have not myself met with in Calcutta, distinguishing them by an asterisk prefixed to the serial number.

One of the most interesting points to which my attention has been drawn in these butterflies is the occurrence of seasonal dimorphism, there being in several species an ocellated form which occurs only in the rains, the cold and dry seasonal being non-ocellated. The constancy of this phenomenon is such that I cannot help thinking there must be some physical reason for it, can it be a protective one? The difference in the garb of the surrounding vegetation makes it little remarkable that a change should be found in the coloration of the butterflies of the two seasons, but it is difficult to see why this change should show itself in the obliteration or development of ocelli. The only hypothesis which I can suggest is, that during the rains the density of the vegetation is such

that the butterflies can easily hide their conspicuous ocelli, while in the cold and dry seasons the ocelli, easily seen through the scantily-clothed jungle, would render the butterflies an easy prey to their inveterate enemies the birds, lizards, and insectivorous insects; so that the ocellation being a cause of danger would have a worse chance of survival, and consequently would be gradually wiped out by a process of a survival of the fittest, the fittest in this case being the least gaudily-marked individuals. Were this the case, however, the non-marked forms would certainly survive during the rains, for their homeliness of coloration, though no longer absolutely essential, would still give them an advantage over their ocellated brethren, unless indeed the ocelli are preserved by sexual selection at this time when the struggle for bare existence is not so keen as at other seasons.

Suborder RHOPALOCERA.

Family NYMPHALIDÆ.

Subfamily DANAINÆ.

* 1. *DANAIS* (PARANTICA) *AGLEA*, Cramer.

I have never met with this species, Mr. Rothney records it as 'rare.'

2. *DANAIS* (TIRUMALA) *LIMNIACE*, Cramer.

Very common everywhere at all seasons.

3. *DANAIS* (LIMNAS) *CHRYSIPPUS*, Linnæus.

The commonest butterfly met with here as elsewhere.

4. *DANAIS* (LIMNAS) *ALCIPPoidES*, Moore.

A single individual has been taken in a garden at Ballygunj in March. Since the first volume of 'The Butterflies of India' appeared, I have received single specimens of this erratic species from Fyzabad in Oudh, from Bholahât in the Malda district, and from Khurda, Orissa. I have no doubt in my own mind that *D. alcippoides* is a casual variety, aberration, or "sport" of *D. chrysippus*, which would almost certainly be proved to be the case by breeding from a batch of eggs laid by a female *D. alcippoides*, when I should expect to find all, or nearly all, the resultant butterflies of the true *chrysippus* form.

5. *DANAIS* (SALATURA) *GENUTIA*, Cramer.

Almost as common as the preceding.

6. *DANAIS* (SALATURA) *HEGESIPPUS*, Cramer.

Decidedly a rare species, I have only seen seven specimens in all, five taken by myself in the two last months of three successive years, one taken by Mr. W. Doherty also in the cold weather, and one in March

in a garden at Ballygunj; all these specimens, except the last, were taken in the Sealdah district. This species is exceedingly common in some localities, Rangoon for instance; its rarity in Calcutta is a strange circumstance.

7. *EUPLEA* (*CRASTIA*) *CORE*, Cramer.

A very common species occurring at all seasons.

8. *EUPLEA* (*PADEMMA*) *KOLLARI*, Felder.

By no means a rare species, and occurs in company with the preceding. Both species have a very strong but not actually disagreeable odour, which neither my friends nor I are able to compare with any named scent. The males of both species may often be observed patrolling a small aerial space with the end of the abdomen curled under the body towards the thorax, and with the two beautiful yellow anal tufts of long hair distended to their fullest extent at right angles to the body. It seems very probable that these tufts or brushes of hair are used like holy-water sprinklers (*aspergilli*) for disseminating the scent with which their bodies are charged as an attraction for the females or to warn off their enemies; but it should be observed that the females are similarly odoriferous, though they are unfurnished with the male disseminating organs.

Mr. Moore in one of his tables* of "Mimetic species of *Eupleinæ* [= *Danainæ*] (Group B)" gives these two species, with another that does not occur in the Calcutta district, as mimics. As far as these two species go at any rate, I do not think he is justified in surmising that one mimics the other. In the first place, as both are strong-scented, and, as far as my olfactory nerves show, have the same scent, it seems impossible to say which is the model and which the mimic, though *E. core* is the commoner species of the two. Again, for the same reason both would be equally distasteful to their enemies. On the wing I can generally distinguish the males of *E. kollari* from *E. core*; it is impossible, however, to distinguish between the opposite sexes of either of the two species when flying.

Subfamily SATYRINÆ.

9. *MYCALESIS* (*ORSOTRIÆNA*) *MEDUS*, Fabricius.

Occurs somewhat sparsely during the rains, not met with in the winter or hot weather.

10. *MYCALESIS* (*ORSOTRIÆNA*) *RUNKA*, Moore.

As above, but met with only in the cold and dry weather. I think it will hereafter be proved by breeding that these two supposed species are but seasonal forms of one species. For some reason at present un-

* Proc. Zool. Soc. Lond. 1883, p. 209.

known, the rainy season seems to give birth to ocellated forms amongst the *Satyrinæ*.

11. MYCALESIS (CALYSISME) BLASIUS, Fabricius.

Not uncommon during the rains. The glandular patch of scales which is placed on the underside of the forewing on the submedian nervure in the middle of a nacreous patch in the male is black and small. Mr. Rothney's list gives an additional species (*M. samba*).

12. MYCALESIS (CALYSISME) PERSEUS, Fabricius.

Very common during the cold and hot weather. The glandular patch is black and small.

13. MYCALESIS (CALYSISME) MINEUS, Linnæus.

Not uncommon during the rains. The glandular patch in this species is ochreous and large.

14. MYCALESIS (CALYSISME) INDISTANS, Moore.

Common during the cold and hot weather. The glandular patch is ochreous and large.

Summary of the four preceding species. Breeding will almost undoubtedly prove that *M. perseus* is the dry season and *M. blasius* the wet season generation of one species, and that similarly *M. indistans* is the dry season and *M. mineus* the wet season generation of a second species, thus reducing the species of the subgenus *Calysisme* occurring in Calcutta to two species, an ocellated form of both with an inner white fascia (*M. blasius* and *M. mineus*) occurring during the rains, and a non-ocellated form with the white fascia obsolescent (*M. perseus* and *M. indistans*) occurring during the dry season.

15. LETHE EUROPA, Fabricius.

In the cold weather this species affects dry ditches. It occurs also during the rains.

16. YPTHEMA PHILOMELA, Johanssen.

Common amongst grass throughout the rains.

17. YPTHEMA MARSHALLII, Butler.

Common everywhere during the cold and hot weather. This and the preceding species are probably seasonal forms of one and the same species.

18. YPTHEMA HUEBNERI, Kirby.

Common everywhere during the rains.

19. YPTHEMA HOWRA, Moore.

Common everywhere during the cold and hot seasons. Similarly this species and *Y. huebneri* are probably but two generations of one and the same species, the strongly ocellated form in both cases occurring during the wet season.

20. MELANITIS LEDA, Linnæus.

Very rare in Calcutta in the early winter, common during the rains.

21. *MELANITIS ISMENE*, Cramer.

Common in the cold and dry seasons. Keeps in shade under trees and bushes and amongst dead leaves during the day, but flies about rapidly in the evening. I have but little doubt that this and the preceding species are but seasonal forms of a single species.

Subfamily ELYMNINÆ.

22. *ELYMNIA UNDULARIS*, Drury.

A common species. Feeds on *Palmaceæ*.

Subfamily MORPHINÆ.

23. *DISCOPHORA TULLIA*, Cramer.

I have taken this species in dry ditches during the cold weather only.

*24. *DISCOPHORA ZAL*, Westwood.

I have not met with this species. My Calcutta females of *D. tullia* do not at all agree with Westwood's figure of *D. zal*. Mr. Moore informs me (*in epis.*) that "*D. tullia* and *D. zal* are undoubtedly distinct species" and that he has "one male of *D. zal*, and it agrees well with its female, of which I have specimens, in having three rows of well-defined spots on both fore and hindwings."

Mr. Moore has of late placed some of the genera usually included under the subfamily *Morphinæ* under the subfamily *Nymphalinæ*. Had he ever had an opportunity of seeing these species alive, I am sure he would certainly never have done so; all of them affecting shade, flying but little unless disturbed, and resting near the ground with closed wings usually amongst dead leaves. In these habits they agree with the *Satyrinæ*, in which subfamily they might perhaps be placed, though in my opinion they are better left under a subfamily of their own; the bold flight and sunshine-loving habits of the *Nymphalinæ* (most of which, moreover, rest with wide-open wings) seeming entirely to forbid their being associated with that family.

Subfamily ACRÆINÆ.

25. *TELCHINIA VIOLE*, Fabricius.

Common throughout the year.

Subfamily NYMPHALINÆ.

26. *CETHOSIA CYANE*, Drury.

A single worn female taken in the cold weather in a garden at Alipur.

*27. *CIRRHOCHROA ANJIRA*, Moore.

Mr. Rothney captured a single female specimen at Barrackpore. I have never met with it in Calcutta, but have received a single female from Bholahát in the Malda District.

28. *ATELLA PHALANTA*, Drury.

A very common insect at all seasons.

29. *PYRAMEIS CARDUI*, Linnæus.

A single female in the Botanical Gardens in November, one male at Ballygunj in March taken by Mr. T. G. H. Monereiffe.

30. *JUNONIA LEMONIAS*, Linnæus.

31. *JUNONIA ATLITES*, Linnæus.

Placed under *Precis laomedea* in the Barrackpore list.

32. *JUNONIA CENONE*, Linnæus.

Common in the Botanical Gardens.

33. *JUNONIA ORITHYA*, Linnæus.

Somewhat rare in Calcutta.

34. *JUNONIA ASTERIE*, Linnæus.

35. *JUNONIA ALMANA*, Linnæus.

J. almana is almost undoubtedly the dry season and *J. asterie* the wet season form of one and the same species.

36. *PRECIS IPHITA*, Cramer.

A single male taken in March in a garden at Ballygunj.

37. *ERGOLIS INDICA*, Moore.

Common. Larvæ feed on *Tagia involucrata*, a twining plant with hairy stinging leaves.

Mr. Moore has lately separated this species from the Javan *E. ariadne*; under which name it appeared in the Barrackpore list.

38. *ERGOLIS MERIONE*, Cramer.

Common. Larva feeds on the castor-oil plant, *Ricinus communis*.

39. *HYPOLIMNAS BOLINA*, Linnæus.

Common except in the cold weather. Mr. Moore also gives *H. jacinthæ*, Drury, as a separate species. I believe it, however, to be one of the numerous varieties or seasonal forms of *H. bolina*.

40. *HYPOLIMNAS MISSIPPUS*, Linnæus.

Much rarer than *H. bolina*. Both forms of the female occur here. The larva feeds on *Portulaca meridiana* in Calcutta.

41. *LIMENITIS PROCRIS*, Cramer.

Common, fond of settling high up in the trees with wings widely spread open. Larva feeds on *Anthocephalus cadamba*.

42. *NEPTIS NANDINA*, Moore.

I have taken this insect in the cold weather only; it is rare.

43. *NEPTIS OPHIANA*, Moore.

I have taken a single female specimen only in February.

44. NEPTIS JUMBAH, Moore.

Common. It has a much bolder and stronger flight than the other species of *Neptis* occurring in Calcutta, and differs from every species of the genus known to me in having a small round brown spot near the base of the hindwing on the underside.

45. NEPTIS KAMARUPA, Moore.

The commonest *Neptis* occurring in Calcutta, and on the wing throughout the year.

46. NEPTIS VARMONA, Moore.

There are three specimens of this species in the Indian Museum, Calcutta, but I have never taken it here. It is recorded from Barrackpore.

47. NEPTIS (RAHINDA) PLAGIOSA, Moore.

Somewhat rare, taken in the cold weather only.

48. ATHYMA PERIUS, Linnæus.

Two specimens only taken in the cold weather.

49. EUTHALIA GARUDA, Moore.

Very common. Larva feeds on mangoe.

50. EUTHALIA LUBENTINA, Cramer.

Rare. I have taken females only.

51. SYMPHÆDRA NAIS, Forster.

A single specimen taken by Mr. R. E. S. Thomas in Calcutta, which is probably its extreme eastward range. Common in the Rajmahal Hills.

52. CHARAXES FABIVS, Fabricius.

Somewhat rare. I have taken nearly all my specimens in the cold weather, sucking up the juice from the date-palms when cut for toddy. It occurs also in the rains.

53. CHARAXES *prox.* HINDIA, Butler.

I took a single female specimen in a garden at Alipur in the cold weather which agrees fairly with *C. hindia*. It has a narrow rufous outer margin to the upperside of the forewing, and the outer black macular fascia on the hindwing less conspicuous than in that species.

Family LEMONIIDÆ.

Subfamily NEMEOBIINÆ.

54. ABISARA SUFFUSA, Moore.

Common at all times except in the three coldest months. Has a very quick flight, but settles often on the upperside of a leaf in the shade with half-expanded wings.

Family LYCÆNIDÆ.

55. SPALGIS EPIUS, Westwood.

Taken on two occasions only in August in the Botanical Gardens flying about a pomegranate bush.

56. MEGISEA THWAITESI, Moore.

A single specimen taken in February. It probably is often overlooked owing to its close general resemblance to the species of the genus *Neopithecops*, which often actually swarm amongst bushes in shade.

57. NEOPITHECOPS GAURA, Moore.

58. NEOPITHECOPS ZALMORA, Butler.

This species has never been properly characterized, and I am unable to say in what particulars it is supposed to differ from *N. gaura*. At any rate the species of *Neopithecops* occurring in Calcutta are exceedingly variable, some specimens are entirely black on the upperside, others have the costal and outer margins of the fore and hindwings black, all the rest of the surface white, and there is every gradation between these extremes.

Mr. Moore writes to me—" *N. gaura* can be distinguished by its broad white discal area in both wings of both sexes. *N. zalmora* has a small discal white patch in the forewing only. I have both from the Calcutta district."

59. CURETIS THETYS, Drury.

Not uncommon amongst trees and high bushes, it generally settles with closed wings on the underside of a leaf out of reach. The female is dimorphic, one form having the discs of the wings above white, the other having them ochreous.

60. CHILADES VARUNANA, Moore.

Not common.

61. CHILADES LAIUS, Cramer.

Not common. It is synonymous with the *C. kandura* of Moore.

62. ZIZERA KARSANDRA, Moore.

Not common.

63. ZIZERA DILUTA, Felder.

Common everywhere amongst grass.

64. ZIZERA SANGRA, Moore.

Swarms amongst the grass at certain seasons.

65. ZIZERA PYGMÆA, Snellen.

Somewhat rare.

66. TARUCUS THEOPHRASTUS, Fabricius.

Rare.

67. TARUCUS PLINIUS, Fabricius.

Somewhat common. Very pugnacious.

68. CASTALIUS ROSIMON, Fabricius.

Fairly common amongst grass.

69. JAMIDES BOCHUS, Cramer.

Common amongst trees.

70. *LYCÆNESTHES BENGALENSIS*, Moore.

Rare, occurs throughout the year.

71. *NACADUBA ARDATES*, Moore.

Rare. Occurs amongst bushes.

72. *CATOCHRYSOPS STRABO*, Fabricius.

Common.

73. *CATOCHRYSOPS CNEJUS*, Fabricius.

Common.

74. *CATOCHRYSOPS PANDAVA*, Horsfield.

Common. In April and May I have found the larvæ swarming on the hardly-open shoots of *Cycas revoluta*, thereby utterly destroying the appearance of the plant for the year. There is also a brood out in the rains.

75. *CATOCHRYSOPS BENGALIA*, n. sp.

MALE. UPPERSIDE violet-blue; the *cilia* dusky. *Forewing* with the outer margin narrowly black. *Hindwing* with a marginal series of dusky oval spots, the third from the anal angle larger, black and round; an anteciliary black line; tail dusky with a white tip. UNDERSIDE gray; the *cilia* gray spotted with dusky. *Forewing* with a white-bordered brownish spot closing the cell, a curved discal series of joined similar spots, two series of marginal lunules; a black anteciliary line. *Hindwing* with four subbasal dusky spots surrounded with white. A much curved discal series, the upper spot on the costa usually the most prominent, and a spot closing the cell; marginal lunules much as in the forewing, but more prominent; a small black spot faintly crowned with orange in the first median interspace and three very minute anal ones beyond it, all four sometimes absent. In some specimens the discal series of spots on the forewing are much elongated towards the middle of the wing, and in all the specimens I have seen, except two from Sikkim, the spots on the disc and the one closing the cell of the hindwing have coalesced, forming an irregular brown patch in the middle of the wing, which patch sometimes reaches and includes the subbasal spots.

FEMALE. UPPERSIDE shining iridescent violet-blue. *Forewing* with the apex widely and the outer margin decreasingly black. *Hindwing* with the costal margin dusky. Otherwise as in the male.

EXPANSE: ♂ ♀, 1·2 inches.

Near to *C. pandava*, Horsfield. Male smaller than that species, of a paler shade of blue; differing on the underside, in the coalescing of the discal spots, and the anal spots of the hindwing being much smaller or absent altogether. The female on the upperside is of quite a different shade of blue, which colour reaches to the costa and much nearer to the margin in the forewing, and covers all the hindwing except the costal

margin. The marginal series of black spots are smaller, more regular in size, and the third from the anal angle not conspicuously crowned with orange as in *C. pundava*.

I have taken numerous specimens of both sexes in the cold weather in Calcutta, and Mr. Nevill took it at Moiraka. It occurs also in Sikkim.

76. *POLYOMMATUS BÆTICUS*, Linnæus.

Common.

77. *LAMPIDES ÆLIANUS*, Fabricius.

Common.

78. *LAMPIDES ELPIS*, Godart.

Rare.

79. *IRAOTA MÆCENAS*, Fabricius.

Rare. Occurs amongst trees, especially the banyan-tree, on which the larva feeds.

80. *DEUDORIX DIENECES*, Hewitson.

Taken only in the winter on the flowers of *Poinsettia pulcherrima*.

81. *BASPA MELAMPUS*, Cramer.

I have taken a male and two females only.

82. *RATHINDA AMOR*, Fabricius.

Recorded from Calcutta by Mr. Moore in P. Z. S. 1865, p. 776, under the name of *Myrina triopas*, Cramer.

83. *VIRACHOLA ISOCRATES*, Fabricius.

Common in the winter on the *Poinsettia*. Larva bred in March from the fruit of the pomegranate.

84. *RAPALA SCHISTACEA*, Moore.

Very common throughout the year. I have bred the larva from a plant growing in the Botanical Gardens, Calcutta. The larva and pupa agree exactly with the figures of an undetermined species given in Horsfield and Moore's Cat. Lep. Ins. Mus. E. I. Co. pl. xii, figs. 4, 4a., and which is probably *Rapala varuna*, Horsfield, a Javan species.

85. *RAPALA ORSEIS*, Hewitson.

A single male specimen taken in April on the flowers of *Diospyros montana*. *R. lazulina* from Ceylon is very closely allied to this species, but unlike my specimen it is not glossed with purple on the underside, which Hewitson gives as a distinguishing character of his *R. orseis*.

86. *SPINDASIS KHURDANA*, Moore.

A single male has been so identified by Mr. Moore.

87. *SPINDASIS TRIFURCATA*, Moore.

There is a single male specimen in the collection of the Indian Museum, Calcutta.

88. SPINDASIS VULCANUS, Fabricius.

This species appears in Mr. Rothney's list under its synonymic name *Aphnæus etolus*. It is the commonest species of the genus occurring in Calcutta.

89. SPINDASIS TIGRINA, Moore.

Mr. Moore has identified some Calcutta specimens of *Spindasis* as this species. He has also queried other specimens of this and the preceding species; which, taken with the fact that *S. vulcanus* is very variable and the differences given between it and *S. tigrina* are very slight, suggests the suspicion that the latter species is at best but a doubtfully good one.

90. TAJURIA LONGINUS, Fabricius.

I have taken it rather plentifully in the winter on the flowers of the *Poinsettia*. It occurs also at other seasons.

91. PRATAPA CLEOBIS, Godart.

Taken with the preceding.

92. SITHON INDRA, Moore.

Rare, but occurs at all seasons. I have taken males only.

93. LOXURA ATYMNUS, Cramer.

Common.

94. MAHATHALA AMERIA, Hewitson.

Rare, always found high up amongst trees.

95. NILASERA AMANTES, Hewitson.

I took a single male specimen in the Botanical Gardens in May.

96. SATADRA ATRAX, Hewitson.

Recorded from Calcutta by Mr. Moore in P. Z. S. 1865, p. 774. Captain Sage has taken a single specimen in May.

97. AMBLYPODIA NARADOIDES, Moore.

I have seen a single female only of this species, which was taken in the compound of the Indian Museum, Calcutta.

Family PAPILIONIDÆ.

Subfamily PIERINÆ.

98. LEPTOSIA XIPHIA, Fabricius.

Met with commonly almost throughout the year.

99. TERIAS HECABE, Linnæus.

Common at all seasons. The males of this, as of all the species of the *T. hecabe* group, have the scales on both sides of a small portion of the median nervure of the forewing near the base on the

underside of a pale violet colour, and the subjacent portion of the wing membrane slightly depressed. On holding a male insect up to the light this secondary sexual character can be at once detected.

100. *TERIAS SIMULATA*, Moore.

This species and the next have the male mark above referred to.

101. *TERIAS PURREEA*, Moore.

Taken in the cold weather, not common.

102. *TERIAS LÆTA*, Boisduval.

There is one specimen of this species in the Indian Museum, Calcutta. *T. læta* and allied species have in the male an oval patch of ochreous scales on the underside of the forewing near the base below the median nervure.

103. *TERIAS DRONA*, Horsfield.

104. *TERIAS RUBELLA*, Wallace.

Taken in December.

105. *CATOPSILIA CATILLA*, Cramer.

106. *CATOPSILIA CROCALE*, Cramer.

Feeds on *Cassia fistula*.

107. *CATOPSILIA GNOMA*, Fabricius.

108. *CATOPSILIA PYRANTHE*, Linnæus.

Feeds on *Cassia fistula*.

*109. *CATOPSILIA ILEA*, Fabricius.

110. *IXIAS GANDUCA*, Moore.

Occurs in February, and again during the rains. *I. latifasciata*, Butler, is given in Mr. Rothney's list, but *I. ganduca* is probably meant.

111. *IXIAS MARIANNE*, Cramer.

Very rare.

112. *HUPHINA PHEYNE*, Fabricius.

Common, feeds on *Capparis horrida*. It appears in Mr. Rothney's list under its synonymic name *H. evagete*, Cramer (*teste* Moore, P. Z. S. 1882, p. 255.)

113. *HUPHINA HIRA*, Moore.

I think that this is only a seasonal (winter) form of the preceding species, which is a very variable one.

114. *HUPHINA ZEUXIPPE*, Cramer.

This also appears to me to be a seasonal or varietal form of *H. phryne*.

*115. *CATOPHAGA PAULINA*, Cramer.

116. *CATOPHAGA DARADA*, Felder.

I have taken a single male specimen only in August.

117. *APPIAS ZELMIRA*, Cramer.

I have seen a single male specimen taken in Calcutta.

118. *APPIAS HIPPOIDES*, Moore.

I took a single male in a garden at Sealdah in November.

119. *HIPOSCRITIA IMBECILIS*, Moore.

A single male taken in February. It differs from that species in having the markings of the underside more pronounced, and also in having a diffused black spot on the underside of the forewing between the upper median nervules. It is doubtfully distinct from *H. indra*, Moore.

120. *BELENOIS MESENTINA*, Cramer.

Common. Feeds on *Capparis horrida*.

121. *NEPHERONIA GÆA*, Felder.

Very common. The female is dimorphic; the form which has the base of the wings yellow is rare. Feeds on *Capparis horrida*.

*122. *NEPHERONIA HIPPIA*, Fabricius.

I have taken but one species of *Nepheronia* in Calcutta. *N. hippia* is unknown to me; unless it is synonymic with *N. gaea*, which is very probable. Mr. Wallace in his paper* on Eastern *Pieride* unites them as one species.

123. *DELIAS EUCCHARIS*, Drury.

Swarms in the winter, specimens are to be met with throughout the year.

124. *DELIAS HIERTE*, var. *INDICA*, Wallace.

A single male taken in February.

Subfamily PAPILIONINÆ.

125. *PAPILIO (PATHYSA) NOMIUS*, Esper.

This species comes out in profusion in March, and is the only single-brooded species in Calcutta with which I am acquainted. Larva feeds on *Polyalthia longifolia*.

126. *PAPILIO (ZETIDES) DOSON*, Felder.

Appears about the same time as the preceding, and specimens may be met with throughout the summer, but the spring brood is the largest. Larva feeds on the young leaves only of *Polyalthia longifolia*.

127. *PAPILIO (HARIMALA) CRINO*, Fabricius.

First appears in March, individual specimens met with throughout the hot weather. Very difficult to capture, and the rarest *Papilio* in Calcutta.

128. *PAPILIO (ORPHEIDES) ERITHONIUS*, Cramer.

Very common. I have bred the larva from *Ægle marmelos*.

129. *PAPILIO (ILIADES) POLYMNESTOR*, Cramer.

First appears at the end of March, specimens occur throughout the hot weather. I have bred the larva on pomelo (*Citrus decumana*).

* Trans. Ent. Soc. Lond. 3rd series, vol. iv, p. 388.

130. PAPILIO (LAERTIAS) PAMMON, Linnæus.

The commonest *Papilio* in Calcutta. All three forms of the female occur, the third form which mimics *P. hector* being the rarest. Larva reared on *Glycosmis pentaphylla*, *Ægle marmelos*, and the common lime.

131. PAPILIO (MENELAIDES) ARISTOLOCHIÆ, Fabricius.

Very common. Has a strong scent, and called the 'Rose Butterfly' in consequence by Calcutta schoolboys. Feeds on *Aristolochia*.

132. PAPILIO (MENELAIDES) HECTOR, Linnæus.

Rare in Calcutta, taken in Chandernagore commonly in November. Also has a strong scent, and larva feeds on *Aristolochia*.

133. PAPILIO (CHILASA) DISSIMILIS, Linnæus.

Not rare in the hot weather. On the wing it may often be mistaken for *Danaïis limniace*.

134. PAPILIO (CHILASA) CASYAPA, Moore.

Occurs in the hot weather. Mimics the Calcutta species of *Euplœa*. Both this species and the preceding feed on *Antiaris todicaria*. The larvæ and pupæ of the one are indistinguishable from those of the other, and both species, or species allied to both, occur always together in all parts of India; it therefore appears to me not improbable that they are one and the same species.*

Family HESPERIIDÆ.

135. BADAMIA EXCLAMATIONIS, Fabricius.

Occurs sparingly throughout the year except in the coldest months.

136. PARATA CHROMUS, Cramer.

I took a single male in the garden of the Seven Tanks in July.

137. ASTICTOPTERUS OLIVASCENS, Moore.

Rare. Occurs amongst grass in shade.

138. ASTICTOPTERUS SALSALA, Moore.

A very common species. Mr. Moore informs me that "the female of *A. salsala* has a curved discal row of seven white spots and two lower ochraceous discal spots, and is a larger species than *A. stellifer*, Butler," which latter has been described from Malacca and Ceylon, and appears to me to be identical with *A. salsala*.

139. MATAPA ARIA, Moore.

Common throughout the year, actually swarms on sweet-scented flowers in the evenings during the rains.

140. TELEGONUS THRAX, Fabricius.

Rare. Occurs in September.

* Since writing the above, I accidentally came across the following note in the P. Z. S. 1865, p. 756—"P. dissimilis and P. panope taken in coitu.—A. E. Russell."

141. *GANGARA THYRSIS*, Fabricius.

Not uncommon, flies in the evening, rests during the day, usually on tree trunks, with closed wings. I have reared the larva on the date and other palms.

142. *BAORIS OCEIA*, Hewitson.

A single male taken in August of the normal eight-spotted form. Mr. Moore has lately (P. Z. S. 1883, pp. 532, 533) described two species of this genus from the Andamans and Darjiling respectively which I consider to be only varieties of *B. oceia*, that species in the number of its spots being the most variable hesperid I know, as previously pointed out by Mr. Wood-Mason and myself in a paper on the butterflies of the Andaman Isles (J. A. S. B. 1881, vol. 1, pt. ii, p. 259).

143. *PARNARA KUMARA*, Moore.

A single male taken in February. Mr. Moore places this species in the genus *Baoris*, but, as it lacks the large tuft of hair in the middle of the hindwing on the upperside in the male which is the distinguishing feature of that genus, it appears to be better placed under *Parnara*.

144. *PARNARA NAROOA*, Moore.

A single male taken in the Botanical Gardens in August.

145. *PARNARA FARRI*, Moore.

One female only taken in February.

146. *PARNARA BADA*, Moore.

Common.

147. *PARNARA BEVANI*, Moore.

There is a single pair of this species in the Indian Museum, Calcutta, taken by Mr. Nevill in February, 1871.

148. *SUASTUS GREMIUS*, Fabricius.

Common. Larva reared on the date-palm.

149. *CHAPRA SUBOCHRACEA*, Moore.

Rare. Taken in November.

150. *CHAPRA AGNA*, Moore.

A common species.

151. *TELICOTA BAMBUSÆ*, Moore.

Very common at all seasons.

152. *TELICOTA AUGIAS*, Linnæus.

Rare.

153. *PADRAONA PALMARUM*, Moore.

Common.

154. *PADRAONA DARA*, Kollar.

Rare, taken in August.

155. *AMPITTIA MARO*, Fabricius.

Taken on one occasion in the Botanical Gardens in August.

156. *TARACTROCERA SAGARA*, Moore.

Rare. Taken in May and August.

157. *HALPE BETURIA*, Hewitson.

Common. Generally keeps high up amongst trees.

158. *HYAROTIS ADRASTUS*, Cramer.

Rather common.

159. *TAGIADES RAVI*, Moore.

Rare, rests with out-spread wings, often on the underside of a leaf.

160. *TAGIADES KHASIANA*, Moore.

As above; somewhat plentiful in the rains.

161. *UDASPES FOLUS*, Cramer.

Rather common.

162. *COLADENIA TISSA*, Moore.

I have taken a single male specimen in February in a garden at Alipur. In the rains another brood appears, which differs from the cold weather generation in having the ground-colour of both wings umber-brown, instead of ochreous, and all the black spots and markings more prominent.

163. *HESPERIA GALBA*, Fabricius.

Decidedly rare in Calcutta, but occurs throughout the year.

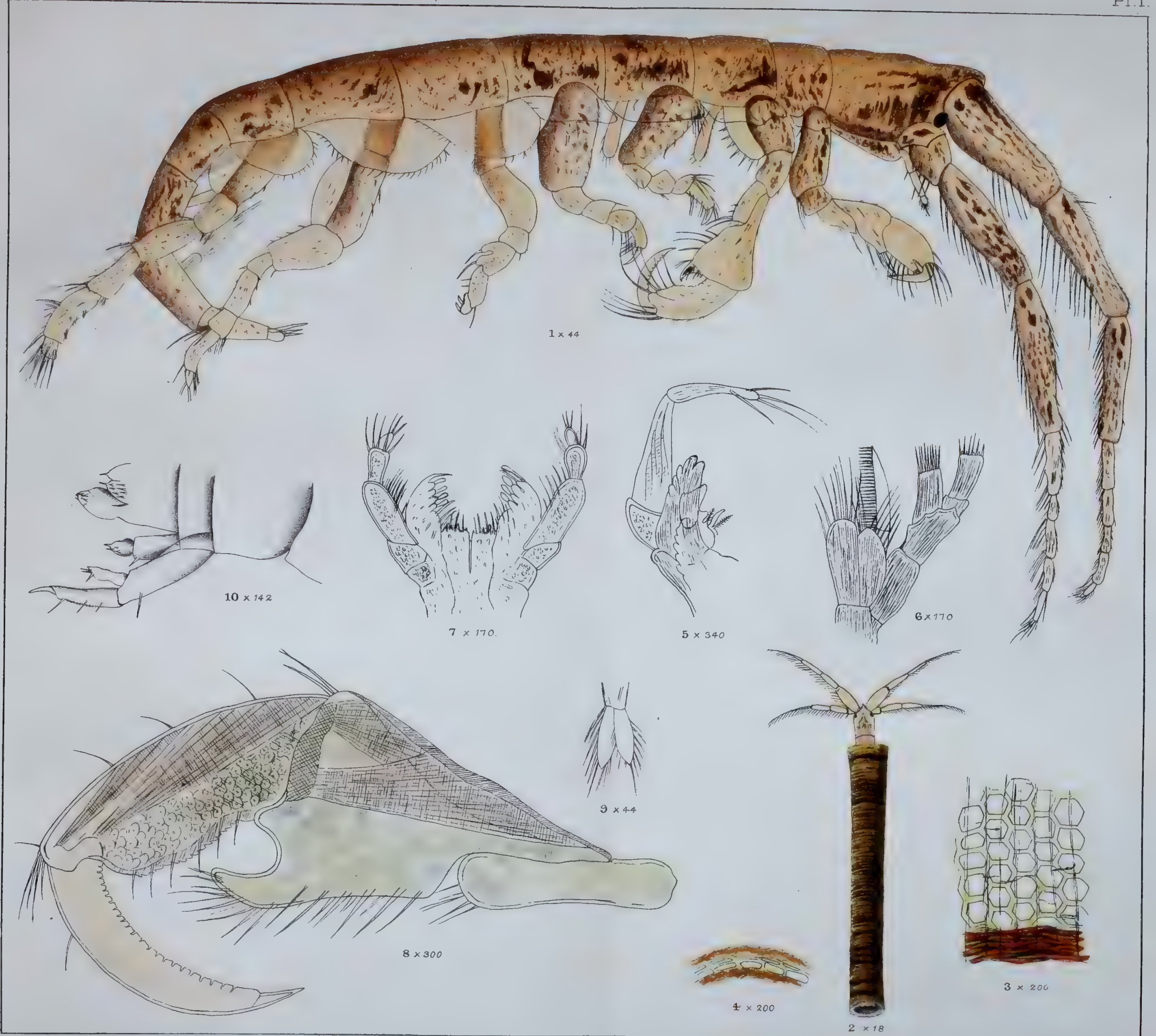
V.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer 'Investigator,' Commander ALFRED CARPENTER, R. N. Commanding. No. 1. On the Structure and Habits of Cyrtophium calamicola, a new Tubicolous Amphipod from the Bay of Bengal.—By G. M. GILES, M. B., F. R. C. S., Surgeon-Naturalist to the Marine Survey.*

(With Plate I.)

[Received 6th March;—Read 1st April, 1885.]

The little organism I am about to describe is one of the numerous objects that are found in the surface-net about the Palmyras shoal and mouth of the Dhamra river on the Orissa Coast. To this, or, at any rate, to such situations, it appears to be confined, for it was not met with either in the deep water of the Bay of Bengal, or in the clear blue shallow water about the Cheduba archipelago.

Shortly after commencing surface-net work in the above locality, I noticed amongst the hauls a body moving with tolerable activity, in appearance much like a morsel of drift wood. It swam about the tube in which it had been placed for observation in a nearly upright posture, sometimes upwards, sometimes obliquely across it, at others allowing itself to sink to the bottom. On closer examination, the four antennæ of a minute crustacean were seen protruding from one end;



G.M.G. del.

CYRTOPIUM CALAMICOLA.

Parker & Coward lith.
West, Newman & Co. chromo.



and it was by the vigorous strokes of these appendages that the little creature was enabled to propel itself with its dwelling through the water. On placing it under a moderate power it was seen to be an Amphipodous crustacean; and it was very curious to observe the cautious way in which first the tips of the antennæ, then the head, and finally the body as far back as the 2nd thoracic somite would be protracted from the stick-like tube, the animal drawing itself back again on the least alarm; further out than this, it appeared disinclined to venture. In order to quiet its movements somewhat, a minute drop of alcohol was added to the water in the cell—a very useful device when it is wished to quiet, without killing, an organism, for after a few vigorous kicks the animal becomes quiet and sluggish, and remains so for some time, until the effects of the dose have worn off;—the moment it felt the touch of the spirit, the little crustacean rushed completely out of its tube, but as quickly dived in again head first. It was noticeable also that, when alive and at ease, it would frequently turn itself inside its tube, and protrude its head from the opposite extremity.

The tubes vary in size from 5—10 mm. long. by 0.5—1 mm. wide, and are nearly cylindrical.

Further examination shewed the Amphipod to belong to the Sub-division Domicola—Family Corophiidæ—Genus *Cyrtophium*.

To the generic characteristics—as adopted by Haswell from Spence Bate in his Catalogue of Australian *Malacostraca*, the only book available to me on board,—our species corresponds very well, but it differs in the antennæ being slightly longer than the antennules and, as well as the posterior abdominal appendages, unprovided with any distinctly curved spines; the latter, however, are furnished with straight spines, which in the natural flexed position of the abdomen are directed forwards, and thus serve equally well for fixation; the spines, moreover, figured for certain species are but very slightly curved. Neither does the relative length of antennæ and antennules afford very trustworthy generic characters: in some of my largest individuals, the antennæ were slightly the shorter, and the number of joints in the flagella of both pairs of appendages presented all variations from three to six. Our species does not, however, appear to be specifically identical with either of the four described by Haswell as known in Australia, or with any in Spence Bate's 'Catalogue of Amphipoda in the British Museum,' which I have since consulted.

From its habit, to be described further on, of making use of a piece of grass or reed as the basis for the construction of its tube, the species may be provisionally named:—

CYRTOPHIUM CALAMICOLA, n. sp.

Length 3—5 mm.

Colour a golden brown plentifully mottled with deep chocolate coloured blotches.

Head subquadrate with a slight beak-like prominence in the middle line. Antennules hairy, as long as the head and the first five segments of the thorax together; their peduncles subequally three-jointed, flagellum (in largest specimens) consisting of six joints, the last joint claw-shaped; length of flagellum to peduncle as 3:8. Antennæ hairy, generally equal to the antennules in length; the peduncle four-jointed, coxocerite very short, fourth joint slightly longer than the third; number of flagellar joints equal to that of the superior antennæ; length of flagellum to peduncle as 5:12. The number of joints in flagella of both superior and inferior antennæ varies considerably: I have met with instances of 3, 4, 5, 6; the joints appear to be always equal.

Thorax. 4th, 5th, and 6th somites of nearly equal length and longer than those before and behind them; 1st the shortest of all. Coxal plates increase in size from before backwards; those of the gnathopoda very small, and, with those of the two following appendages, not long enough to overlap; the posterior three considerably larger, imbricate. 2nd pair of appendages, or anterior gnathopoda, considerably less robust than the posterior; propodite long, ovate; dactylopodite as long as the propodite, its concave border very finely serrate; carpopodite triangular, its articulation with the meropodite so oblique as to coincide nearly with the long axis of the appendage. 3rd pair of appendages, or posterior gnathopoda, very large; dactylopodite as long as the propodite, provided with a peculiar serrature of square, chisel-edged teeth; propodite long, ovate; carpopodite triangular, its postero-inferior angle produced into a strong tooth with a smaller, less acute tooth close to the posterior border of its articulation with the propodite; articulation of carpopodite with meropodite as in the 1st gnathopod. 4th and 5th pairs of appendages alike in form, with claw-shaped dactylopodite; the latter is, however, much the more robust. 6th pair of appendages differing a good deal from the others; the posterior border of their dactylopodite provided with two curious short finger-like processes. 7th and 8th pairs of appendages alike in general form, the 7th slightly smaller than the 8th, their basipodites having the posterior border strengthened by a lamellar buttress-like expansion; dactylopodite rounded and provided with a large tuft of hairs; both these appendages are habitually kept extended backwards in the long axis of the body.

Abdomen. Anterior three appendages of the usual swimmeret type;

anterior the largest, the 3rd the smallest; 4th with the rami unequal, the internal ramus two-jointed, projecting backwards and inwards behind the telson like a pair of horns; 5th smaller than the fourth, with internal ramus rudimentary; 6th rudimentary, bud-shaped, with a few very short, straight, backwardly directed, appressed spines. Telson short, blunt, conical, and armed, at the extremity of the dorsal surface, with spines similar to those on the last abdominal appendages.

The tube inhabited by this little creature is a very curious structure. It is, as a rule, considerably longer than the body of the animal it shelters, being more than capable of completely protecting it, when the antennæ, extended in front of the body, are drawn within. It is of a deep golden brown colour, and, on closer examination, is seen to be closely, but irregularly, banded with zones of darker and lighter tint, varying from a fine golden yellow, through a warm brown, to black. When some of this material is teased out, it is seen to consist of coarse, nearly opaque, fibres uniformly stained throughout, and showing no structure, consisting, indeed, to all appearance, of a hardened secretion. For some time I was in considerable doubt as to the method of its manufacture. At first I had jumped to the conclusion that it was a worm tube that had been appropriated by the *Cyrtophium*, much in the same way that a hermit-crab fits itself with the shell of a dead mollusc. One day, however, I surprised one of the amphipods, in my live trough, evidently in the act of repairing its premises. The animal had completely withdrawn himself into the tube and was keeping it slowly but continuously revolving round him. The specimen was luckily a small one and hence the tube was transparent enough for me to see that the crustacean kept stationary, while the tube revolved. The transparency, however, was not sufficient to enable the exact method of deposition of the fibre to be made out. Shortly after this, a specimen was met with in which about half the tube only was covered with the opaque fibrous material and the other half transparent. On placing this beneath the microscope, I was surprised to find that the transparent portion was a very complex structure consisting of a layer of hexagonal thick-walled cells with an outer layer of long quadrilateral cells; the whole presenting an appearance which left one in no doubt as to its vegetable nature. Moreover, the structure was not that of an alga, and appeared most probably referable to that of some grass or reed. The greater part of this vegetable membrane was coated on both sides with the peculiar opaque fibrous material above described. Pieces of grass such as would serve for this purpose are taken commonly enough in the surface-net in the turbid waters at a river's mouth and are, no doubt, common at the bottom for some considerable distance beyond; indeed, I

have dredged a specimen of a grass in excellent preservation many miles from land in nearly 200 fathoms. It is evident therefore that our *Cyrtophium* would experience no want of building materials in the moderate depths which he inhabits. Subsequent examinations, both by teasing and section, have shewn that this structure is the rule, *viz.*, a vegetable tube covered inside and out with hardened secretion. In some few of the tubes, however, no trace of vegetable structure could be detected; and it is probable that the animal is quite capable of constructing a protection for itself without the aid of such a basis. Haswell, indeed, following Spence Bate (*op. cit.*), appears to take this power as an accepted fact, for he includes the genus *Cyrtophium* in a section named '*Nidifica*' defined as "Having the power of secreting a substance, that, like a web, binds together the material of which the nest is composed, or one of a more membranous character." It appears to me, too, that the intricate peculiarities of the form of the limbs tends to corroborate this view. The peculiar teeth of the dactylopodite of the second gnathopod are clearly suited only for cutting, and the organ would be admirably adapted for trimming a piece of grass to suit its purpose, or for severing the thread of secretion; it is to be noticed that they are quite different from those of the anterior gnathopod, the serratures of which are simple like those of a saw. Again, the distal joint of the 6th thoracic appendages is admirably adapted for guiding a thread, but is so shaped as to be nearly useless either for ordinary progression or for manipulating the food. I have not been able to satisfy myself as to the position of the gland which would be necessary for the production of such a secretion. Cement-glands have been described in the gnathopodal propodites, and glands of a probably different nature also in more or fewer of the bases of the thoracic limbs. Glands are observable in both these situations in this species. The posterior part of the huge propodal joint of the 2nd gnathopod is filled with a collection of rounded nucleate cells which, so far as can be seen through the chitinous cuticle, appears essentially of a glandular character, and from its volume I am strongly inclined to believe is the organ concerned in the production of the membrane-forming secretion.

All attempts at keeping the animal in captivity failed. Even when kept in a large bulk of water aerated by means of a pressure-apparatus, specimens soon died, whether they were turned out of their tubes or allowed to retain them. This could hardly have been for want of oxygen, for a fish, exceeding the *Cyrtophium* many hundred times in bulk, was kept alive in the same apparatus for over five days under precisely the same circumstances. It is probable that the clearness of the water indispensable for observation had something to do with this.

EXPLANATION OF PLATE I.

- Fig. 1. *Cyrtophium calamicola*, n. sp., drawn to scale, $\times 44$.
 2. The same in its tube, in the act of swimming, $\times 18$.
 3. Portion of an unfinished tube showing a vegetable membrane lined at one end with opaque silk-like fibres, $\times 200$ (about).
 4. Small portion of a transverse section of a tube, $\times 200$ (about).
 5. A mandible, $\times 340$.
 6. 1st and 2nd maxillæ, $\times 170$.
 7. Maxillipedes, $\times 170$.
 8. Subchela of third thoracic appendages, showing the peculiar teeth of the dactylopodite and the glandular body in the propodite, $\times 300$ (about).
 9. One of the anterior abdominal appendages, $\times 64$.
 10. The three terminal abdominal appendages, with telson, from above, $\times 142$.

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VI.—*Notes on Japanese Land and Freshwater Molluscs.*—By O. F. VON MÖLLENDORFF, PH. D. Communicated by the NATURAL HISTORY SECRETARY.

[Received April 3rd;—Read May 6th, 1885.]

The following notes are based chiefly on a collection made by Dr. John Anderson during the year 1884 and sent by him to Deputy Surgeon General Hungerford and myself for classification. I take this opportunity to publish some new species formerly discovered by Messrs. Hungerford and Eastlake, and to give some corrections to my former paper on Japanese *Clausilia* published in this Journal (Vol. LI, Pt. II, 1882).

1. *NANINA JAPONICA*, n. sp.

*Testa depresso-globosa, semiobtectæ perforata, acute carinata, superne striis curvatis transversis costuliformibus distantibus sculpta, subtus laevigata, nitida, tenuis, subpellucida, flavescens; anfr. 6 fere plani, ultimus non descendens, basi inflatus, apertura obliqua, lunaris, peristoma rectum, acutum, margine columellari ad perforationem reflexo.*

*Diam.*  $11\frac{1}{2}$ , *alt.*  $6\frac{1}{2}$  mill.

*HAB.* Specimen unicum ad Sengoku legit cl. Dr. Anderson.

The first *Nanina* known from Japan; I am not sure about its subgenus, which can hardly be ascertained without examining the animal. The nearest relation is apparently my *N. eastlakeana* from Fuchow in China (Jahrb. d. Mal. Ges. 1882, 371), which is somewhat larger and flatter. I think both species should be classed with *N. indica*, Pfr., which G. Nevill (Handl. Moll. Ind. Mus, 1878, 27) has under "subgenus doubtful," whilst Pfeiffer considers it to be a carinate *Macrochlamys*.

Another *Nanina* (*Macrochlamys*?, *Hemiplecta*?) at least 24 mill.



in diameter, I received from Mr. F. W. Eastlake, who obtained it in Nippon; it is, however, in too bad condition to be described.

2. *HYALINIA (CONULUS) TENERA*, A. Adams. One specimen from Chitose, Yeso.

3. *HYALINIA (EUHYALINA) YESSOENSIS*, Reinh., Sitz. Ber. Ges. Nat. Fr. Berlin, 17th April 1877, p. 91. Jahrb. d. Mal. Ges. IV, 1877, p. 314, t. IX, f. 6.—Kobelt, Faun. Jap. p. 8, t. I. f. 2.

Hakodadi (A. Adams, *Hilgendorf*). Onuma, Poronai, Chitose, Eastern Yeso (Anderson).

4. *PATULA PAUPER*, Gould. From various localities in Yeso, where it had already been collected. Known besides from Kamchatka, the Amoor, and North China.

5. *HELIX SIMILARIS*, Fér. Specimens from Yeso (Poronai) quite agree with the Chinese forms of this cosmopolitan snail. This is, so far as I know, the most northerly habitat of the species.

6. *HELIX PECULIARIS*, A. Adams. Hills of Hakoni, where Mr. Eastlake likewise collected this rare species.

7. *HELIX JAPONICA*, Pfr. Yeso.

8. *HELIX BLAKEI*, Neroc, Proc. Acad. Calif. III, 1861, p. 160, *vide* E. von Martens, Sitz. Ber. Nat. Fr. Berlin, 17th April 1877, p. 105. Kobelt, Faun. Jap. p. 23, t. VII, f. 10, 11.

A snail which Dr. Anderson obtained at Chitose, Yeso, agrees perfectly with Kobelt's description and figure of *Helix blakei*, Neroc, the original description of which I am unable to compare. Dr. Hilgendorf collected the same species near Hakodadi. I do not think the shell can be classed in the subgenus *Aegista*, as Kobelt has it, but would place it in *Camena*.

9. *HELIX PELIOMPHALA*, Pfr. Typical forms from Kamahura, Ishiyama in Central Japan; a small rather high variety from several places in Yeso.

10. *HELIX AMALIE*, Kobelt. Quite corresponding to the author's figure, from Kiga.

11. *HELIX LUHUANA*, Sow. Kiga.

12. *HELIX QUÆSITA*, Fér. A curious small form, light brown without a band, but otherwise typical, from Ogenohama, Yeso.

13. *HELIX LÆTA*, Gould. Onuma, Chitose, Ogenohama (Yeso). Originally described from Hakodadi. The specimens for the greater part (like most of the snails collected) not full grown, are partly without hands.

14. *BULIMINUS ANDERSONIANUS*, n. sp.

*Testa profunde rimata, turrito-conica, tenuis, striis transversalibus et lineis spiralibus rugulosis quasi granulata, corneofusca; anfr. 7½—8*

*convexusculi, sutura impressa discreti, ultimus magnus antice paululum ascendens. Apertura parum obliqua, truncato-elliptica, peristoma expansum, reflexiusculum, marginibus callo tenui junctis, externo arcuato, columella subplicata.*

Long.  $21\frac{1}{2}$ , lat. 8, apert. alt.  $7\frac{1}{2}$ , lat.  $5\frac{1}{2}$  mill.

HAB. Ad Onuma, Poronai insulæ Yeso leg. cl. Dr. Anderson.

This fine *Buliminus* differs from the only species known from Japan, *B. reinianus*, Kob., in its smaller size, much more conical spire, broader base, deeper umbilical slit, but principally by its very distinct sculpture consisting of transverse striation and rather irregular spiral lines which together produce a granulose aspect of the cuticle.

# 15. BULIMINUS JAPONICUS, n. sp.

*Testa rimata, ovato-turrita, solidula, oblique striatula (albida?, cornea?); anfr.  $7\frac{1}{2}$  vix convexi, sutura impressa discreti, ultimus basi rotundatus  $\frac{1}{2}$  totius altitudinis adaequans; apertura parum obliqua, truncato-elliptica, peristoma expansum, reflexiusculum, marginibus callo sat valido junctis, columella haud angulata nec plicata.*

Long. 28, lat. 11, apert. long. 11, lat. 8 mill.

HAB. Prope urbem Osaka, comm. cl. F. W. Eastlake.

The unique specimen of a *Buliminus* which Mr. F. W. Eastlake has sent me for description appears to differ specifically from *B. reinianus* in its much more ventricose almost ovate shape and its greater solidity, in having  $\frac{1}{2}$  a whorl less, the last whorl higher, the lip of the peristome broader, the parietal callus thicker, and the columella not plicate. The specimen being dead and faded, I cannot describe the colour, which is most likely brownish.

# 16. STENOGYRA (OPEAS) PYRGULA, A. Adams.

A single specimen from Onuma, Yeso. I have received the same species from the Nikko mountains, where it was collected by Mr. F. W. Eastlake.

## Genus CLAUSILIA, Drap.

### Group *Euphaedusa*, Böttg.

17. CLAUSILIA PRABA, A. Ad. The localities Utsonoma and Mamada (Nippon) given in my former paper (J. A. S. B. LI, Pt. II, 1882) were inserted by mistake, the species collected there being *Cl. tau*, Böttg. *Cl. proba* has only been found on the island of Kiushiu and in the Korean Archipelago.

### Group *Stereophaedusa*, Böttg.

# 18. CLAUSILIA TETRPTYX, v. Mölldff., l. c. p. 7, t. I, f. 7.

I find that this form does not belong to the group of *Cl. validiuscula*, v. Mart, as formerly stated, but to that of *Cl. brevior*, v. Mart. I could

not break up a specimen at the time, and by looking into the shell I must have got an entirely erroneous view of the clausilium, which is essential for determining the subsection. Furthermore, I had only an imperfect knowledge of *Cl. brevior*, which is not very well represented by the figure in Kobelt's *Fauna Japonica*, but of which I have since received authentic specimens. *Cl. tetraptyx* is a little larger (but this does not matter much, as *Cl. brevior* is rather variable in size), the colour is brown with a reddish tint, whilst *Cl. brevior* is pale horn-coloured, the peristome is broader, slightly lipped and liver-coloured, its upper sinuation somewhat deeper. The palatal plaits are somewhat longer and farther up in the interior of the shell. Altogether I think *Cl. tetraptyx* is hardly more than a variety of *Cl. brevior*.

I subjoin the description of a new form of this interesting little group which Mr. F. W. Eastlake has discovered near Nikko.

19. *CLAUSILIA NIKKOENSIS*, n. sp.

*Testa elongato-fusiformis, pallide cornea, subtiliter sed distincte striata; anfr. 10½—11 convexiusculi; apertura ovalis, parum obliqua, peristoma continuum, superne solutum paullum sinuatum, expansiusculum. Lamella supera sat valida, marginalis, cum spirali continua, infera valida, valde torta, intus subfurcata, usque ad marginem producta, subcolumellaris emersa, plica principalis elongata, palatales 5 breves, superior et infima paullo longiores. Clausilium latum, subtus rotundatum.*

*Long. 18, diam. 3½ mill.*

This species is distinguished from *Cl. brevior* by the longer and much slenderer shell, the more elongate aperture with higher "sinulus", the lower parietal lamella reaching the margin of the peristome, the upper lamella being less high.

#### Group *Megalophaedusa*, Böttg.

20. *CLAUSILIA MARTENSI*, Herklots, MS.—E. v. Martens, *Mal. Bl.* VII, 1860, p. 40; Albers-Mart., *Hel.* 1860, p. 275; *Ostas. Landschn.* 1867, p. 32. Pfeiffer, *Mon. Hel.* VI, 1868, p. 494, VIII, 1877, p. 519. A. Adams, A. & M. N. H. 4th ser. I, p. 469. Kobelt, *Faun. Jap.* p. 79, t. VIII, f. 1—4. *Cl. reiniana*, Kobelt (olim) *J. d. Mal. Ges.* II, 1875, p. 330, t. XII, f. 7-9, *ibid.*, III, 1876, p. 154, t. V, f. 8. Pfeiffer, *Mon. Hel.* VIII, 1877, p. 471. *Cl. yocohamensis*, Crosse, *J. de Conch.* XXI, 1873, p. 68, t. V, fig. 3, 3a. Pfeiffer, *Mon. Hel.* VIII, p. 481. Böttger, *Claus. Stud.* 1876, p. 62. Kobelt, *Faun. Japon.* p. 81, t. VIII, f. 5—9. *Cl. yocohamensis*, var. *reiniana*, Böttger, *Claus. Stud.* 1876, p. 62. Pfeiffer-Clessin, *Nomencl. Hel.* p. 392.

From what I have seen of the big Japanese *Clausiliae* I do not believe that two species can be recognised. The characters by which



they are to be distinguished vary a good deal even at the same locality, especially the more or less visible subcolumellar lamella. If Kobelt's identification of his *Cl. reiniana* with *Cl. martense*, Herklots, is correct, as I think it is, then *Cl. yocohamensis*, Crosse, will have to follow suit. Perhaps varieties may be distinguished, but for this purpose the habitats of the different forms will have to be more exactly recorded than they have hitherto been.

Dr. Anderson obtained one dead specimen of a *Megalophaedusa* at Mianoshda; if the two species are to be separated, this would be *Cl. yocohamensis*, Crosse.

21. *CLAUSILIA DUCALIS*, Kobelt. A single specimen from Hakoni, where Mr. R. Hungerford collected the same species before.

Group *Cylindrophaedusa*, Böttg.

My friend Dr. Böttger does not quite agree with me in classing *Cl. gracilispira*, mihi (l. c. p. 5, t. I, f. 5), with the Himalayan *Cl. cylindrica*, Gray, and would rather propose to insert it in the group of *Cl. validiuscula*, Mart. (*Hemiphaedusa* subgroup 1.). The species does not seem to agree perfectly with either of the two groups, but the shape of the shell and of the lower parietal lamella are certainly nearer those of *Cl. cylindrica*. Another question is, whether *Cylindrophaedusa* can be upheld as a separate subsection at all. The investigation of Western and Central China will probably enable us to decide these questions.

*Clausilia micropeas*, mihi, is certainly no *Cylindrophaedusa*, as I shall show further on.

Group *Hemiphaedusa*, Böttg.

(a) Subgroup of *Cl. validiuscula*, v. Mart.

As mentioned above *Cl. tetrptyxa*, mihi, is to be removed from this subgroup.

(β) Subgroup of *Cl. sublunellata*, Mölldff.

The following species form a subgroup of their own within the section *Hemiphaedusa*, to which they undoubtedly belong on account of their very receding, almost straight, lower parietal lamella and their narrow clausilium. The first subgroup, that of *Cl. validiuscula*, shows, instead of a lunella, a number of lateral palatal plaits, whilst the following subgroups have a more or less straight lunella and no 'palatales' except the principal one.

The following species, however, have below the principal plait, first an upper palatal, after this a very short second one, and then a short straight lunella, which in some forms is somewhat obsolete, but always discernible. We have, therefore, in these forms, a remarkable transitional group between that of *Cl. validiuscula* and the other *Hemiphaedusae*.

22. *CLAUSILIA SUBLUNELLATA*, n. sp.

*Testa ventricosofusiformis, tenuissime striatula, solidula, corneofusca, anfr. 11 subplani, superiores quattuor spiram cylindricam obtusam efficientes, ceteri celeriter accrescentes, duo penultimi maximi, ultimus attenuatus basi rotundatus. Apertura elongata piriformis, sinulus rectus, peristoma fere solutum, valde incrassatum, reflexiusculum. Lamella supera valida, obliqua, marginalis, intus triangulariter elevata, cum spirali continua, infera recedens, stricta, intus valida, subcolumellaris immersa, oblique intuenti intus conspicua. Plica principalis modica (lineam lateralem superans), palatales duae, supera principali subparallela brevis, infera brevissima, lunella brevis, strictiuscula. Clausilium?*

*Long. 24, diam. 5, apert. long 6, lat. 4 mill.*

HAB. In montibus Nikko leg. cl. F. W. Eastlake.

23. *CLAUSILIA SERICINA*, v. Mölldff. (l. c. p. 6, t. I, f. 4), which Mr. Hungerford collected in the same region, and which I cannot compare at present, will probably prove to be a near relation to *Cl. sublunellata*, and undoubtedly belongs to the same subgroup.

24. *CLAUSILIA SUBULINA*, v. Mölldff, l. c. p. 13.

One specimen collected by Mr. F. W. Eastlake in the Nikko mountains agrees perfectly with my diagnosis of the above species, of which Mr. Hungerford possesses the only example found. It has the peculiar arrangement of the palatal plaits in common with *Cl. sublunellata*, viz., an upper palatal plait under the principalis, then a shorter one, and below this a short straight lunella, which is, however, not so distinct. *Cl. subulina* is the only species of the subgroup in which the subcolumellar lamella reaches the peristome.

25. *CLAUSILIA MICROPEAS*, v. Mölldff., l. c. p. 12.

The idea of classing this small form with *Cl. gracilispira*, mihi, in the sub-section *Cylindrophaedusa* has to be given up entirely; the lower parietal lamella requiring its being placed in *Hemiphaedusa*. I find, further, that there is an indication of a lunella below the second (generally punctiform) palatal plait. The species therefore fits very well into our present subgroup.

Mr. F. W. Eastlake collected a single specimen on his tour to Nikko without noting a special locality. Lake Chusinji, where Mr. Hungerford obtained the species, is not far from Nikko.

26. *CLAUSILIA OPEAS*, n. sp.

*Testa cylindraceofusiformis, subtiliter striatula, solidula, cornea, anfr. 10½ planulati, ultimus rugosostriatus, apertura elongato-rotundata, peristoma solutum, expansum, reflexiusculum, leviter incrassatum. Lamella supera marginalis, modica, infera remota vix conspicua, intus valida, subcolumellaris immersa oblique intuenti conspicua. Plica principalis*

*lineam lateralem via superans, palatalis supera brevis divergens, infera punctiformis, lunella brevis stricta. Clausilium?*

*Long.*  $17\frac{1}{2}$ , *diam.*  $3\frac{1}{2}$ , *apert. long.*  $3\frac{1}{2}$ , *lat.*  $2\frac{1}{2}$  mill.

HAB. In montibus Nikko leg. cl. F. W. Eastlake.

Another species of the same subgroup, at once distinguished by the cylindraceous slender shell.

(γ) Subgroup of *Cl. platydera*, v. Mart.

27. CLAUSILIA PLATYAUCHEN, v. Mart., Sitz. Ber. Ges. Naturf. Fr. Berlin, 17th April, 1877, p. 110. Böttger, Claus. Stud. p. 67. Kobelt, Faun. Jap. t. IX, f. 8. *Cl. fusangensis*, v. Mölldff, l. c. p. 8, t. I, f. 8.

My friend Dr. Böttger has pointed out to me that my species is the same as von Martens' previously published *Cl. platyauchen*, of which I had not seen a specimen, and which is not very accurately figured in Kobelt's Fauna of Japan. I have since convinced myself that Dr. Böttger is right.

Dr. Anderson collected a small variety of the same species at Chusinji which is only 23—25 mill. in length.

(δ) Subgroup of *Cl. strictaluna*, Böttg.

28. CLAUSILIA STRICTALUNA, Böttg., var. *nana*, n.

*Differt a typo testâ multo minore, ventricosiore, aperturâ magis rotundatâ, lamellâ subcolumellari immersâ.*

*Long.* 9—10, *lat.*  $2\frac{3}{4}$  mill.

Nagasaki (*Hungerford*). This dwarf form, although closely related to *Cl. strictaluna*, may ultimately be considered to be a separate species, if a greater number of examples of both can be examined.

29. CLAUSILIA AURANTIACA, Böttg., var. *ERBERI*, Böttg.

My var. *minor* (l. c. p. 9) is the same as Böttger's var. *erberi*, as the author has himself confirmed.

30. CLAUSILIA PLICILABRIS, A. Adams, A. & M. N. H. 4th ser. X, 1868, p. 469. Pfeiffer, Mon. Hel. VIII, 1877, p. 476.

This rare species has been found by Mr. F. W. Eastlake on his tour to Nikko, and by Mr. B. Schmacker in the Hakoni mountains.

(ε) Subgroup of *Cl. caryostoma*, v. Mölldff.

31. CLAUSILIA CARYOSTOMA, v. Mölldff., l. c. p. 6, t. I, f. 5.

This interesting species is certainly a *Hemiphaedusa*. The "ventral" position of the palatal plaits bring it near to the subgroup of *Cl. strictaluna*, in which especially *Cl. aurantiaca* shows the same receding position of the closing apparatus. My former remark that a lunella is deficient has to be rectified, inasmuch as the punctiform plait between the two 'palatales' may very well be considered to be a short lunella.



(δ) Subgroup of *Cl. hyperolia*, v. Mart.

Of this subgroup, I described in my former paper two new species, *Cl. rectaluna* and *Cl. aptychia*, but having since received more material for study from Messrs. Eastlake, Schmacker, and Anderson I am now convinced that they have to be reduced to varieties, or, perhaps, even mere forms, of *Cl. hyperolia*. I was led into this error by the scanty supply of specimens; and this is a characteristic instance of the difficulty, if not impossibility, of getting a correct idea of a species of *Clausilia*, especially in the Asiatic groups, from single individuals. *Cl. hyperolia* seems to be very variable in size, shape, etc., but none of the distinguishing characters of the various local forms seems to be of specific value. I now propose to distinguish the following varieties.

32. *CLAUSILIA HYPEROLIA*, v. Mart., *type*, 17-20 mill. in length. Near Tokio (*Hilgendorf*, *Rein*, *Schmacker*), hills on the way to Nikko and Kawasaki (*Eastlake*).

Var. *RECTALUNA*, v. Mölldff., somewhat more slender, of pale horny colour, with a rudimentary principal plait; the other characters given (l. c. p. 9) are not constant, inasmuch as the spiral bands or lines are often deficient in the type itself, whilst the *lamella infera* often terminates in the same way as described in *Cl. rectaluna*.

Kamatokogiro (*Hungerford*).

Var. *APTCHIA*, v. Mölldff., larger, up to 25 mill. long, upper parietal lamella somewhat smaller, lower lamella a little more visible in the aperture, the lunella sometimes, but not always, evanescent.

Dr. Anderson collected this form in some numbers at Hakoni and Chusinji, the former place being the original habitat. It is very variable in size and somewhat also in shape, form of the aperture, and thickness of the peristome.

Var. *PLANULATA*, v. Möll., *differt a typo testâ longiore, multo gracilliore, anfractibus planulatis, lamellâ superâ humili, inferâ magis recedente, antice inconspicuâ*.

Two specimens from Kobi (*Eastlake*). Of all the forms, this has perhaps the best claim to specific distinction, and, if the characters as given above prove constant in a greater number of examples, it had better be separated, especially as the locality is widely distant from those of the other varieties.

33. *SUCCINEA LAUTA*, Gould. Hakodadi, Oginohama, Poronai, Chitose, all on the island of Yeso, where the species had been previously found.

34. *LIMNÆUS JAPONICUS*, Jay. Lake Chusinji, Yeso.

35. *LIMNÆUS PERVIUS*, v. Mart. Central Japan.

36. *ALYCEUS NIPPONENSIS*, Reinh. Yeddo (*Dönitz*, *Hilgendorf*), Nikko and Hakoni mountains (*Eastlake*), and Mianoshda (*Anderson*).

37. DIPLOMMATINA LABIOSA, v. Mart., Sitz. Ber. Ges. Nat. Fr. 17 April 1877, p. 98. Kobelt, Faun. Jap. p. 112, non *D. labiosa*, W. T. Blanford, J. A. S. B. XXXVII, Pt. 2, 1868.

This fine *Diplommatina*, which has, so far as I know, not yet been figured, requires renaming on account of *D. labiosa*, Blanf. As this has probably been already done, I mention the species under the old name in order to avoid a superfluous synonym.

It was discovered by Dr. Hilgendorf in the Hakoni mountains, where Messrs. Hungerford and Eastlake have since collected it. Hungerford also found it at Asinoin, and Anderson at Myiokishita.

38. DIPLOMMATINA NIPPONENSIS, n. sp.

*Testa dextrorsa, rimata, elongate ovato-conica, subtiliter sed distincte et regulariter striatula, rufescenticornea, anfr. 7 convexi, superiores spiram conicam acutiusculam efficientes, duo ultimi parvulum distorti, ultimus angustior, antice ascendens. Apertura fere verticalis, subcircularis, peristoma duplex, reflexiusculum, expansum, superne in anfractum penultimum productum. Lamella columellaris humilis spiraliter recedens, plica palatalis longiuscula, supra aperturam conspicua.*

*Long.*  $2\frac{1}{2}$ , *diam.*  $1\frac{1}{2}$  mill.

HAB. Ad Asinoin leg. cl. R. Hungerford, in montibus Hakoni leg. cl. F. W. Eastlake.

So far as I know, only two species of *Diplommatina* have been described from Japan, the preceding and *D. pusilla*, v. Mart. From both of these our new form is widely different. The nearest are *D. pavillus*, Gredl., of Central China and *D. hungerfordiana*, Nev., of Formosa; which are both a little larger, and much more regular and rounder in shape, while *D. nipponensis* is at once distinguished by the regular pointed cone of the upper whorls and the distorted suddenly enlarged lower ones. The sculpture of our species is much more regular, the columellar margin of the peristome is rounded, hardly angulate at all, whilst *D. hungerfordiana* is slightly subangulate, and *D. pavillus* distinctly angulate at the base.

39. JAPONIA BARBATA, Gould. I am indebted to Mr. F. W. Eastlake for some specimens of this rare shell which were collected by him in the Hakoni mountains. They have enabled me to settle the vexed question of what *Japonia*, Gould, really is. Gould says nothing about its affinities, E. von Martens (Ostas. Landschn. 1867, 12, 127) supposed it to be related to *Cyclotus*, and Pfeiffer placed it at first near *Hydrocena*, later on considering it to be a section of *Realia*. The descriptions of the genus and its three species given by Gould are, it is true, so incomplete and vague that very little can be concluded from them. The examples collected by Mr. Eastlake agree very well with the description of *T. barbata*, Gould;

at the same time they show close relationship to the small species of sculptured *Cyclophori* described from China, viz., *C. trichophorus*, *mihi*, *sexifilaris*, Heude, etc. These do not, however, as I have lately found out and shall elsewhere prove, belong to *Cyclophorus*, but to *Lagochilus*; and, from the analogy of the shells, I do not doubt that the Japanese species will have to be placed in the same genus. In that case fanatic adherents of strict priority might contend that this genus should be named *Japonia* (published 1859) instead of *Lagochilus* (1864), but, as the few words by which *Japonia* was introduced cannot be called a scientific description, whereas *Lagochilus* was properly described and published by Blanford, I hope nobody will contest the validity of the latter name. Should it be found that the Chinese and Japanese species deserve to be separated from the Indian forms as a section of their own, *Japonia* should be retained as its name.

40. *HELICINA JAPONICA*, A. Adams. Sengoku (*Anderson*), Minoshda Hills, Chusinji (*Hungerford*).

41. *MELANIA LIBERTINA*, Gould. In various forms from the Hakoni Lake, Kiga, Central Japan, and Yeso. I quite agree with E. von Martens and Kobelt, who combine *M. japonica*, Reeve, *M. tenuisulcata*, Dunker, *M. ambidextra*, v. Mart., and *M. reiniana*, Brot, all with *M. libertina*, Gould; as frequent transitions from one form to another are to be found.

42. *MELANIA NIPPONICA*, Edg. Smith. Lake Biwa.

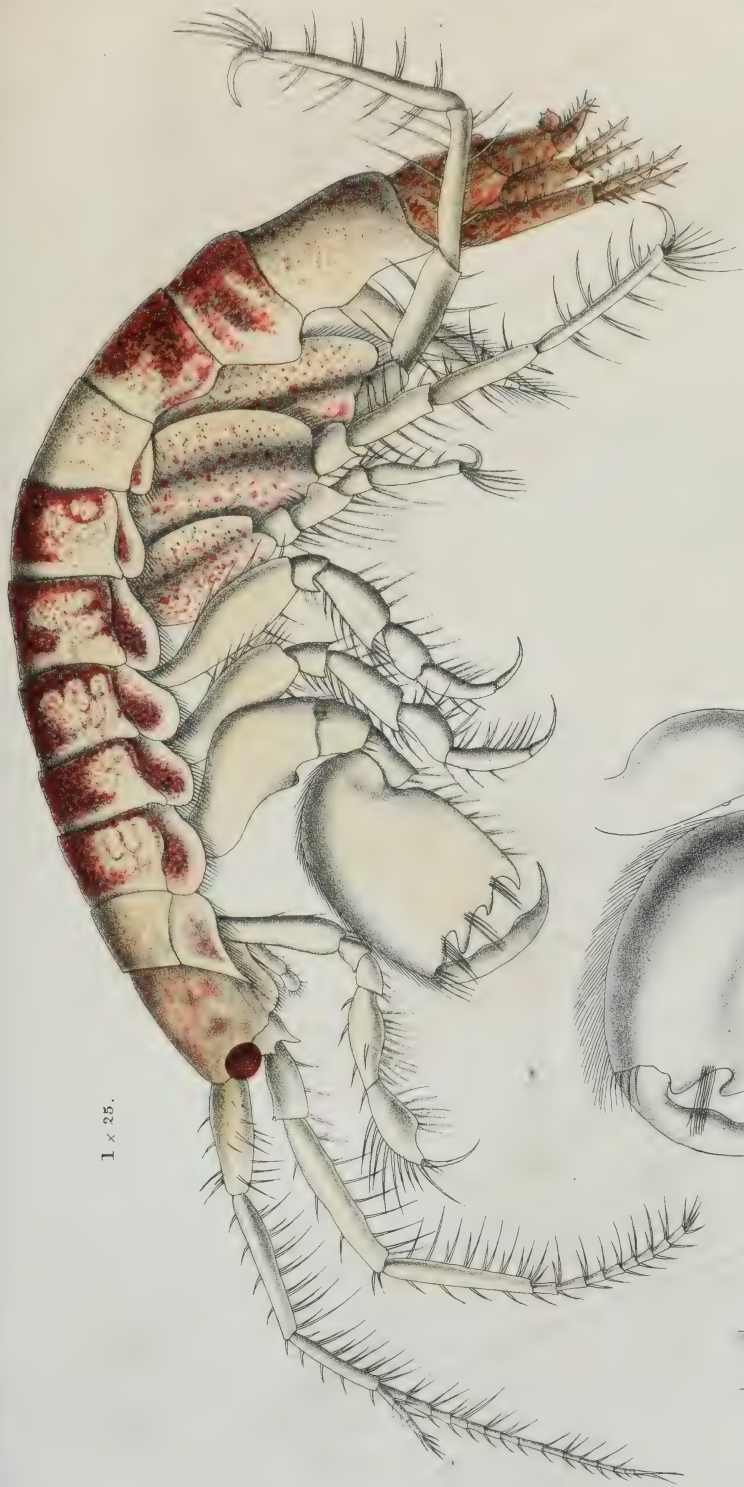
43. *MELANIA BIWÆ*, Kobelt. Lake Biwa. Messrs. Hungerford, Schmacker, and Anderson have collected this fine species in some numbers, and I have seen no transitional forms which would necessitate its combination with the preceding species.

The *Paludinae* collected by Dr. Anderson are all young or imperfect specimens.





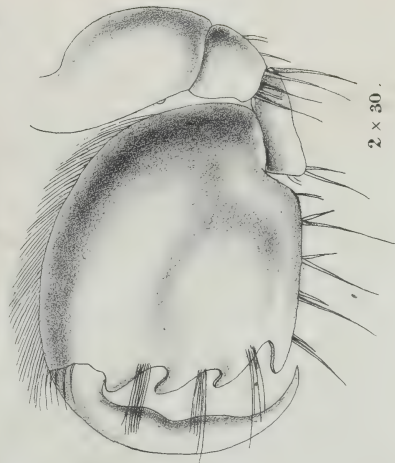
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# JOURNAL

OF THE

## ASIATIC SOCIETY OF BENGAL.

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### Part II.—NATURAL SCIENCE.

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No. II.—1885.

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VII.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer 'Investigator,' Commander ALFRED CARPENTER, R. N., Commanding. No. 2. Description of a new Species of the Amphipod Genus Melita from the Bay of Bengal.—By G. M. GILES, M. B., F. R. C. S., Surgeon-Naturalist, Indian Marine Survey.*

[Received April 21st ;—Read May 6th, 1885.]

(With Plate III.)

The little animal described below was brought up by the hempen tangles from  $12\frac{1}{2}$  fathoms near the Mutla Light Ship. When placed in a glass jar, it shewed a tendency to hide itself away amongst the pieces of tangle which remained sticking to some specimens of *Murex spinosa* that had been placed in the jar along with it, and when disturbed escaped by rapid backward jerks.

Two specimens were taken, one slightly larger than the other. The larger was used for dissection and proved to be a female. The smaller was reserved for preservation. Fig. 1. was taken from it. The relative proportions of its parts appeared identical in all respects with those of the larger, with the exception of the propodite and dactylopodite of the second gnathopod, which in the larger specimen exceeded in size that of the smaller to an extent out of all proportion to the difference of their sizes, which were about 5 and 6 mm. respectively. Colour—ivory-white marked with patches of chocolate-coloured pigment.



## MELITA MEGACHELES, n. sp.

*Body* generally depressed rather than compressed. Broadest at the middle of the thorax, thence tapering to head and abdomen.

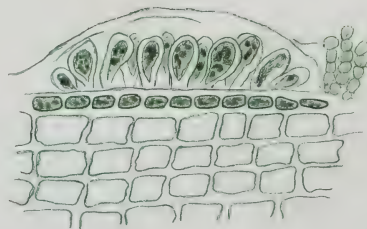
*Head* subquadrate, longer than broad, its depth nearly equalling its length, irregularly mottled with chocolate-coloured spots. Eyes situated at the anterior angles of the carapace, compound, prominent, of a coppery violet colour. Antennules hairy, robust, as long as the head and the anterior six segments of the thorax; peduncle three-jointed, middle joint the longest; flagellum as long as the first two joints of the peduncle; a minute appendage, as long as the last joint of the peduncle, with a dilated antepenultimate joint, springs with the flagellum from the peduncle. Antennæ hairy, slightly shorter than the antennules, arising a little below and behind them; peduncle four-jointed, coxocerite short, its antero-inferior angle prolonged into a pointed prominence; third joint the longest, flagellum equals this in length. Mandibles triangular with a long pediform appendage.

*Thorax* depressed. The posterior three-fourths of each segment decorated with winged patches of madder-brown pigment, except the first and seventh, which are only faintly mottled. Coxal plates considerably less in depth than the segments, decreasing in size from before backwards; the anterior plate quadrangular with its anterior inferior angle prolonged into a beak-like process; the remaining plates foliiform, each with a central patch of pigment. Maxillipedes small, pediform. 2nd pair of appendages (1st gnathopod) very hairy, nearly the smallest of the ambulatory limbs; propodite with palm so vague as to be exungiculate rather than subchelate. 3rd pair of appendages (2nd gnathopod) of relatively immense size; dactylopodite with its posterior margin entire except for two slight smooth prominences; propodite more than twice as wide as the depth of the thorax, quadrangular, with rounded corners, its inferior border furnished with four large reserrations with three isolated bundles of hairs in the intervals. 4th and 5th pairs of appendages subequal, hairy, exungiculate, closely resembling each other in every detail, closely approaching in length to 2nd gnathopod. 6th pair of appendages the shortest of the ambulatory limbs; the basipodite having its posterior border strengthened by a lamellar, buttress-like expansion; the dactylopodite forming a strong claw. 7th and 8th pairs of appendages much resembling each other, but the 8th considerably the larger in all points; basipodites with buttresses like the 6th pair of appendages; the dactylopodites forming long strong claws; the eighth is the longest of all the thoracic limbs.

*Abdomen* somewhat compressed, especially the last four segments, the first two with large pigmented marks, the third faintly blotched, the



1

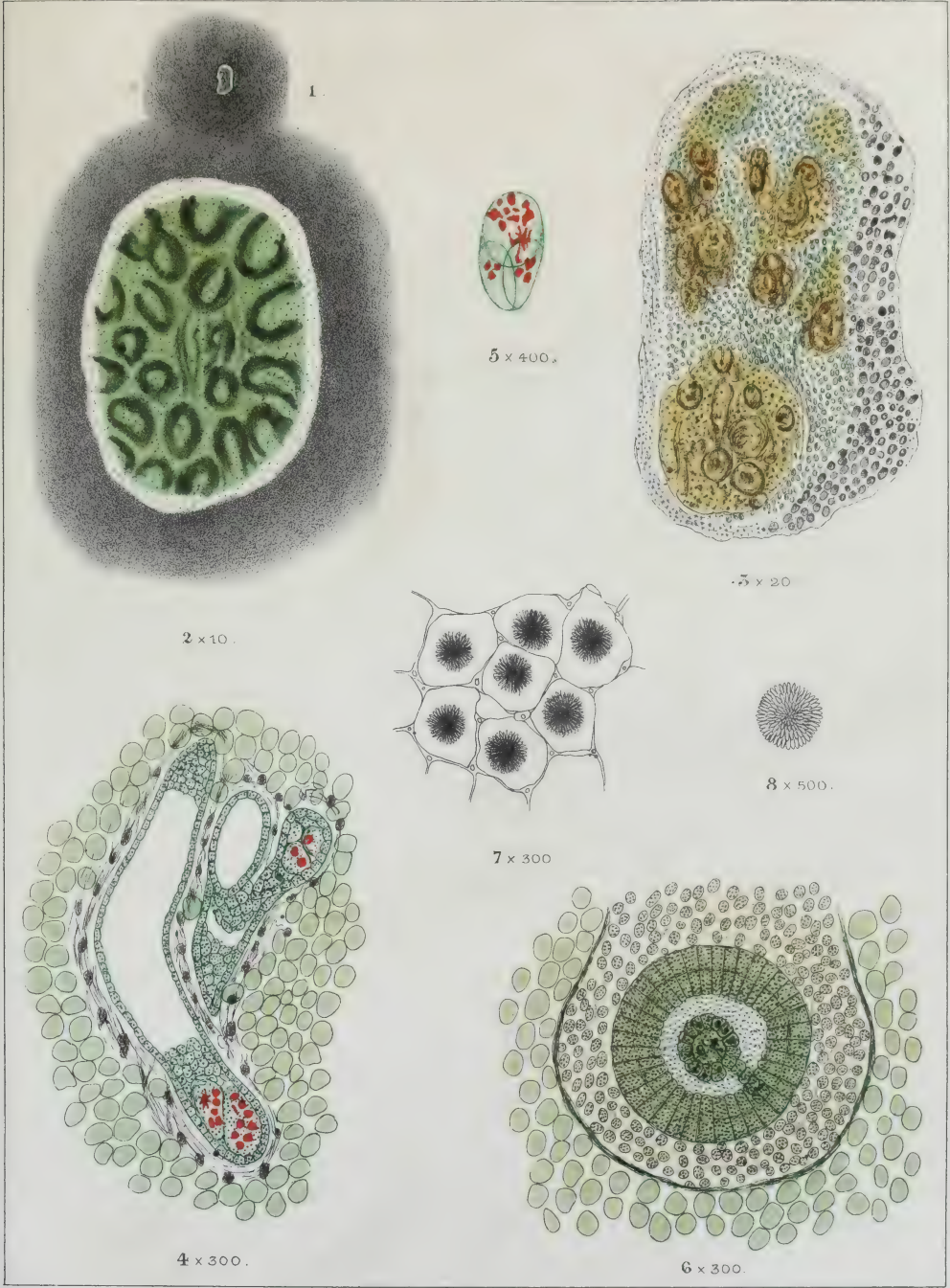


2 x 200.

*Padina pavonia*







*Padina pavonia.*



last three earthy-brown marked with madder-brown blotches. Anterior three pairs of appendages subequal, of the usual amphipodal swimmeret type. 4th and 5th pairs of appendages robust, biramous, the rami subequal with short, stout, straight spines; the fourth much larger than the fifth. 6th pair of appendages short, stout, internal ramus almost rudimentary, armed, like those of the 4th and 5th, with short, stout, straight spines. Telson nodular with a few short spines.

## EXPLANATION OF PLATE III.

Fig. 1. Side view of *Melita megacheles* in natural colours,  $\times 25$ .

Fig. 2. Distal joints of 2nd gnathopod of the female specimen,  $\times 20$  about, i. e., drawn as if belonging to a body on the same scale as fig. 1, to shew the comparative size of these appendages in the two specimens.

Fig. 3. Distal joints of antennular appendage,  $\times 275$ . In the before-mentioned dilated joint are some highly refractile bodies probably of the nature of otoliths.

Fig. 4. Abdominal appendage of the 6th pair,  $\times 60$ .

VIII.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer 'Investigator,' Commander ALFRED CARPENTER, R. N., Commanding. No. 3. On the Prothallus of Padina pavonia.*—By G. M. GILES, M. B., F. R. C. S., Surgeon-Naturalist, Indian Marine Survey.

[Received April 21st;—Read June 6th, 1885.]

(With Plates IV and V.)

The reproductive process of the genus *Padina* is a subject which has, I believe, been involved in some uncertainty.

The most recent work which I possess that deals at all minutely with the marine algæ is the last edition of the Micrographic Dictionary.

In this only one kind of "spore" is described alternating with tufts of jointed hairs (paranemata) "which Agardh appears to have mistaken for antheridia." This is, I believe, a correct surmise, more especially as I have recently had the good fortune to meet with a body which, there can be little doubt, is the prothalloid or sexual stage of the plant; the stage usually found being non-sexual, like that of fully formed ferns.

To the description of the adult plant, as given in the above-quoted work, there is little or nothing to add; but the spores dropped from its indusia give rise not to a similar form but to an alternate stage possessing both kinds of sexual organs.

*Padina pavonia* is a weed very common on the coast of British Burmah, growing on rocky spots, more especially in situations where there is a good deal of sand and mud in the interstices of the rocks.



Some days ago, while collecting marine algæ amongst the rocks of Kyouk Phyou harbour, a place was visited where this plant was exceptionally abundant. It was also as remarkable for its bareness of other algæ, the only others present being *Caulerpa sedoides* and a small rhodospirum not in fruit but probably belonging to the genus *Acanthophora*, and even these were very few and far between.

On the rocks on which the *Padina* were growing was noticed a number of small bodies about 5 mm. in diameter of a beautiful deep green colour, and generally of oval outline. Some of these were growing actually on the fronds of the *Padina*, while immense numbers were clustered on the rocks around.

On closer examination, with a pocket lens, it was seen that in many instances very young fronds of the *Padina* were sprouting from the circumference of the green bodies. On taking these up, it was observable that the little buttons of tissue were beginning to shrivel and decay, and that the young *Padina* fronds were firmly attached to their remains.

These circumstances appeared to point to some intimate connection between the two growths, and a number of the "prothalli" were accordingly collected and carried back to the ship for more minute examination.

On placing one of them beneath a Coddington lens, it was seen that the green substance was encased in a coating of white transparent tissue, much thicker and more opaque on its under than on its upper surface. The green substance itself was beautifully marbled with oval or circular markings of a deeper green than the rest.

These points having been noted and drawn, one of the specimens was placed in the microtome and a number of transverse sections taken. On placing these beneath the microscope, a structure of really wonderful complexity was displayed (Fig. 3.) Enveloping the mass is the white tissue, in which, so far as could be seen, there are no apertures. This tissue is composed of a network of stellate cells with anastomosing tails, exactly like the structure known in animal histology as adenoid connective tissue; in the meshes of this, on the under surface of the prothallus, are enclosed a number of opaque bodies to be more minutely described further on. Enclosed in this are a number of tubular bodies, containing the reproductive organs, supported by bands of tissue springing from the peripheral layer. The space between these is filled up by a mass of spherical nutritive cells containing abundant chlorophyll.

To return to the "tubular" bodies. These are scattered, in masses, irregularly through the central substance; and, on closer examination, there are readily distinguishable in each mass two kinds of bodies, differing markedly in size and contents, though evidently primarily of the same morphological character.

From the appearances presented in section, as well as from teased preparations, it is evident that, in each case, we have to do with specialized tubular masses of cells embedded in a tissue consisting of cells differing somewhat from the "nutritive cells" that form the body of the central mass, and more liberally permeated with bands of the adeniform tissue.

Let us first take the smaller kind. Through the greater part of their length they are simple tubes consisting of a sort of basement membrane, lined with small flattened granular cells, containing but little chlorophyll, about 5 m. in diameter. They appeared to end cæcally, and their lower part was filled with masses of cells having the following characteristics. Each little mass (Fig. 5) consists of a mother-cell of oval form about 40 m. long by 25 m. cross measurement, containing three daughter-cells. In the interior of these latter a curious change was in the process, resulting in the formation of a number of small spherules of a brilliant carmine colour about 2 or 3 m. in diameter, which in their turn break up into a number of minute rods of the same bright colour about 2 or 3 m. long by 1 m. or less in diameter. From the general characteristics of this organ, there can be little doubt that these rods come under the category of antherozoids, and that the organs themselves are antheridia.

The larger tubes are usually found in close proximity to the smaller kind, being commonly enclosed in the same sheath of small-celled tissue. Their cellular lining is usually much thicker than that of the antheridial tubes consisting usually of at least two layers of larger cells. The greater part of their length is usually filled up with mother and daughter cells, differing from those of the antheridial tubes in containing no coloured spherules or rods, and in the more abundantly granular character of their contents. The portion of the section shewn in Fig. 6. appears to shew their mode of origin: here a cell of the lining has grown out into the lumen of the tube, and has produced a string of cells which has curled round on itself for a turn and a half in a circinate manner; the oldest cell in the middle of the helix is dividing into daughter-cells; some of these, however, were elsewhere met with of considerably greater size than those shewn here, which are obviously in the earliest stage of their development.

So far as could be made out, these tubes had no communication with the exterior, being rather of the nature of closed elongated sacs. Many were met with in a broken-down condition; and fertilization no doubt takes place by this retrogressive process setting free the ripe contents of the tubes, which, being thus liberated in close proximity, and suspended in the grumous matter resulting from the degeneration of the

tube structure, can hardly fail to be brought into actual contact by the gentle osmotic currents which must always be in progress in such a structure as this.

This supposition is strengthened by the fact that young *Padina* fronds appear always to spring up, not in the neighbourhood of, but actually from the substance of the decaying prothallus. There can be little doubt, then, that the two kinds of tubular body are respectively of the nature of antheridia and archegonia. The rod-shaped produce of the smaller form make its antheridial nature little doubtful, and the produce of the larger kind is so much like the spores produced by directly sexual sea-weeds that there can, I think, be equally little doubt as to the rôle to be assigned to them.

There remain to be described the peculiar opaque bodies previously noted, and as to their nature no such relative certainty can be felt.

The surmise to which one feels most naturally led, is that they may be the fertilized spores in an early stage of development. They are, however, like nothing I have met with elsewhere either amongst algæ or in animal or vegetable histology. The bodies in question (Figs. 7 and 8) lie loose in the meshes of the adeniform tissue of the white peripheral layer of the prothallus. They are from 15 to 25 m. in diameter and of generally spherical form. In their fully developed form they appear to consist of one or more layers of minute colourless rods radiating from a common centre, so that their entire periphery is beset with minute blunt spines, on which account I have named them hedgehog cells. Intermediate stages can be traced between these and cells closely resembling the "spores" of the contents of the larger form of tubular body. They are quite white when seen by direct illumination, while their opacity renders them quite black when examined by transmitted light. They are confined to the under surface of the prothallus, where it comes in contact with the rock and are there very abundant; the lateral and upper parts of the peripheral layer of the thallus being composed of the adeniform tissue without any such contents.

The parts of the central substance between the groups of tubular bodies is filled up with very loose adeniform tissue enclosing in its meshes immense numbers of spherical cells containing abundant chlorophyll. These are from 12 to 15 m. in character, and probably fulfil a nutritive function.

The curious resemblance of the tube-bodies to an ovo-testis can scarcely be missed, and more than once caused me to reflect whether or not the structure might by any possibility be of animal origin. Repeated examinations, however, have assured me that this is not the case and that the body in question is an intermediate stage of the sea-weed in



question. There are many points in connection with these bodies that require clearing up, but these can hardly be solved without continuous observation of the living plant. Like all surf-line weeds, *Padina pavonia* requires a very free supply of oxygen, and the conditions necessary for observing it in, if I may so speak, captivity are wanting on board ship; so that the solution of these points must, I fear, be reserved for other observers more favourably situated. Assuming, however, that the body which has just been described is really the prothallus of this weed, it would render it extremely probable that all algæ producing "spores" of but one kind go through some such cycle of changes; and a very large field of investigation appears in prospective as to the determination of the prothallus of each species. Some no doubt have been described as distinct species of algæ, as, assuming their existence, they can hardly have been entirely overlooked up to now.

## EXPLANATION OF THE PLATES.

## PLATE IV.

Fig. 1. *Padina pavonia*, nat. size. The sori are disposed in concentric lines consisting of a structureless flattened indusial sac and a number of pear-shaped sporanges. Tufts of paraneumata disposed along their sides give to the sori a woolly appearance.

2. Vertical section of frond through a sorus showing sporanges and paraneumata,  $\times 200$ .

## PLATE V.

Fig. 1. Prothallus of *Padina pavonia*, natural size.

„ 2. The same,  $\times 10$ .

„ 3. Transverse section of same,  $\times 20$ .

„ 4. Portion of the section shewing male tubes in oblique section,  $\times 300$ .

„ 5. Male mother-cell containing daughter-cells producing red-pigmented rods,  $\times 400$ .

„ 6. Portion of the section shewing a female tube in transverse section,  $\times 300$ .

„ 7. Adeniform tissue of lower surface of the prothallus containing "hedgehog" cells in its meshes,  $\times 300$ .

„ 8. One of the "hedgehog" cells more carefully drawn,  $\times 500$ .



## IX.—Notes on Indian Rhynchota, No. 3.—By E. T. ATKINSON, B. A.

[Received June 15th ;—Read July 1st, 1885.]

[The notes are taken as far as possible from the original descriptions, most of which are practically unprocurable by observers in India, or from Stål, Signoret, Butler, or Distant &c. where these authors have redescribed a species : the measurements of specimens not in the Indian Museum have been converted into millimetres from the recorded measurements of the several authors.]

The insects belonging to this section have been so little worked in India that the collector may feel sure of a rich harvest of new species. At the same time, we may take warning from the confusion in the results of the investigations into the European forms how very necessary it is, from the similarity in appearance and small size of the great majority of the species, to use the microscope more freely than has apparently hitherto been the practice in ascertaining the generic characters. We must wait some time before we can usefully attempt to do more than collect, compare, and fix the locality for the new forms of *Membracidae* and *Jassidae* which exist in such profusion in this country. In the meantime, these notes summarising what has been done in, as near as possible, the words of the authors, is a contribution to the work.

## Family MEMBRACIDÆ, Stål.

Subfam. *Membracida*, Stål, Hem. Afric. iv. p. 83 (1866) : Fieber, Rev. Mag. Zool. (3 sér.) iii. p. 332 (1875).

## Subfamily CENTROTINA, Stål.

*Centrotida*, Stål, Hem. Afric. iv. p. 83 : Ofvers. K. V.-A. Förh. p. 280 [(1869) : *Centrotina*, *ibid.* p. 727 (1870).

Scutellum distinct, produced backwards behind the metanotum, very often sinuated at the apex and furnished with acute apical angles. The scutellum is wanting in *Oxyrhachis*, which in Hem. Afric. iv. p. 84 (1866) is placed by Stål in his subfamily *Membracida* (*Membracina*), and in Ofvers. Kong. Vet. Aka. Förh. p. 280 (1869) in his subfamily *Centrotida* (*Centrotina*) : in Hem. Fabr. ii. p. 47 (1869), it is again transferred to *Membracina*.

## Genus OXYRHACHIS, Germar.

Silbermann's Rev. Ent. iii. p. 232 (1835) : Fairmaire, A. S. E. F. (2 sér.) iv. p. 267 (1846) ; Stål, Hem. Afric. iv. p. 84 (1866) ; Ofvers. K. V.-A. Förh. p. 280 (1869) ; Fieber, Rev. Mag. Zool. (3 sér.) iii. p. 333 (1875).

Head perpendicular, frons a little elevated : thorax cornuted above the lateral angles, horns three-cornered ; posterior process long,

narrow, broad at the base, gradually narrowed, three-cornered, reaching the interior margin of the tegmina; beneath, posteriorly compressly-amplified, furnished with a ridge continued throughout the entire thorax: tegmina with five oblong, apical areas; wings with three apical areas: sides of the pro- and meso-stethium armed with a small lobe or tooth: tibiæ dilated (Stål).

# 1. OXYRHACHIS TARANDUS, Fabricius.

*Membracis tarandus*, Fabr., Ent. Syst. Suppt. p. 514 (1798).

*Centrotus tarandus*, Fabr., Syst. Rhyng. p. 19 (1803).

*Oxyrhachis tarandus*, Germar, in Silbermann's Rev. Ent. iii. p. 232 (1835): Burmeister, Handb. Ent. ii. (i.) p. 133 (1835): Amyot and Serville, Hist. Nat. Ins. Hém. p. 536 (1843): Fairmaire, A. S. E. F. (2 sér.) iv. p. 268 (1846), t. 4. f. 13: Walker, List Hom. B. M. ii. p. 503 (1851): Stål, Hem. Afric. iv. p. 84 (1866): Hem. Fabr. ii. p. 47 (1869): Fieber, Rev. Mag. Zool. (3 sér.) iv. p. 12 (1876).

Body obscure, dorsum fuscous; pronotum with two compressed horns, arched, obtuse, posteriorly subulate, longer than the abdomen; tegmina hyaline, veins fuscous: wings white; feet ferruginous (*Fabr.*). Long 7-8; breadth of pronotum, 3 millims.

♂. Brown-red; ♀, reddish-yellow or russet; vertex usually russet, sometimes brownish, with two small callosities prolonged to the ocelli, the angles straight: head, or towards the base only, black: the pronotum with a red or russet-yellow median ridge running from the anterior margin, little defined, to the space between the lateral protuberances, thence defined and prolonged throughout the entire posterior process: lateral protuberances of the pronotum turning outwards and backwards and sometimes slightly upwards, a little compressed, varying in size, tip acute or obtuse: the posterior process reaching to or extending beyond the apex of the tegmina by about the fourth of its length, more or less recurved towards the apex, narrowly lanceolate in its posterior half with a median keel on the sides, its lower edge finely serrated: feet with sunken dots, ciliated and setiferous: tegmina sordid hyaline, the two corneous patches at the base and the veins, russet-yellow (or fuscous-ferruginous): abdomen in the ♂, black; all the feet and the venter in the ♀, russet-yellow or reddish. Genitalia in the ♂, seen from above, transversely semioval; seen from the side, trapezoidal, briefly truncated behind and directed obliquely towards the base, and forwards in a weak arch: anal *styli* yellow, projecting on the sides, widened almost into a lozenge-shape, on a short narrow pedicel: anal tube short, cylindrical, brown: genital plates placed one opposite the other, brown, gradually contracted together behind; their tip spatuliform, rounded and relieved: body whitish pubescent.



♀. Last ventral arch obtusely emarginate : lateral plates (*gaîne*) broad, oval, acuminate behind ; vagina (*tarière*) straight, a little longer than the *gaîne* ; anal tube cylindrical, extending beyond the *tarière* : abdomen russet yellow (*Fieb., Stal.*).

Reported from S. France, Egypt, Abyssinia, Senegal, Bengal. The Indian Museum possesses specimens from Calcutta.

## 2. OXYRHACHIS UNICOLOR, Walker.

*Oxyrhachis unicolor*, Walker, List Hom. B. M. ii. p. 509 (1851).

Piceous, densely fulvous pilose : head and pronotum thickly punctured : head transverse, not much broader than long, flat, slightly convex along the posterior margin, truncated in front, a little narrower than the pronotum between the shoulders, the pronotum ridged, rather low, rising vertically from the head, shoulders rounded, not prominent ; horns above conical, prismatic, inclined forward, ascending, slightly diverging, their length equal to rather less than twice the breadth of the pronotum between them : posterior process ridged, reaching well beyond the tip of the abdomen, very slightly tapering from the base to the tip which is acute ; very slightly undulating along the ridge ; legs ferruginous ; femora black ; tibiæ dilated : tegmina almost without colour, long, narrow, lanceolate, punctured, ferruginous and partly tawny at the base ; veins ferruginous, stout : wings colourless (*Walker*). Body long, 6 : wings,  $14\frac{1}{2}$ -15 millims.

## 3. OXYRHACHIS RUDIS, Walker.

*Oxyrhachis rudis*, Walker, List Hom. B. M. ii. p. 509 (1851).

Ferruginous : head piceous, transverse, flat, finely punctured, truncated and with a ferruginous spot on each side in front ; not much broader than long, a little narrower than the pronotum between the shoulders ; pronotum itself very roughly punctured, slightly ridged, rising vertically from the head, with the shoulders rounded not prominent ; horns above very broad, conical, diverging, almost horizontal, slightly curved, disc of the inner side slightly concave towards the base ; posterior side less than half the breadth of any other : posterior process keeled or ridged, extending well beyond the tip of the abdomen, tapering and slightly declining from the base to the middle where it is deepened and keeled beneath and from thence to the tip is serrated beneath and slightly inclined upwards : tibiæ dilated ; tegmina and wings colourless : tegmina narrow, lanceolate, with a small pale brown spot on the angle of the posterior border ; veins thick, ferruginous ; three discoidal areolas (*Walker*). Body long, 6-7 : wings,  $13-14\frac{1}{2}$  millims.

Reported from India.

## 4. OXYRHACHIS SUBJECTA, Walker.

*Oxyrhachis subjecta*, Walker, List Hom. B. M. ii. p. 504 (1851).

Smaller than *O. tarandus*, the dorsal horns shorter in proportion and less diverging, posterior process more inclined upwards and not serrated beneath. Black with a white pubescence: head transverse, subquadrate, flat, slightly impressed, finely punctured, not much broader than long, a little narrower than the pronotum, truncated and ferruginous in front: pronotum somewhat elevated in front, rather roughly punctured, rising almost vertically from the head with a ferruginous keel or ridge: shoulders of pronotum rounded, not prominent: horns above very broad, prismatic, conical, diverging, ascending, hardly curved downwards: posterior side much the shortest of all the sides; length of the horns rather less than the breadth of the pronotum between them: posterior process mostly ferruginous, reaching well beyond the tip of the abdomen, inclined upwards, and ridged beneath, but not serrated from the middle to the tip: pectus and abdomen whitish pubescent: legs red; tibiæ dilated: wings colourless: tegmina tawny, punctured at the base and with a brown spot on the angle of the posterior border; veins stout, ferruginous, four discoidal areolas (*Walker*). Body long 6; wings,  $11\frac{1}{2}$  millims.

Reported from India.

In *O. tarandus*, the pronotum is elevated in front, the posterior process is ridged and also serrated beneath, the length of the horns is rather more than twice the breadth of the pronotum between them, and there are four discoidal areas: in *O. subjecta*, the posterior process is not serrated beneath and the length of the horns is rather less than the breadth of the pronotum between them, otherwise as in *O. tarandus*: in *O. unicolor*, the pronotum is rather low in front and the length of the horns is as in *O. subjecta*: in *O. rudis*, the posterior process is keeled and serrated but there are only three discoidal areas.

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*Species of uncertain position.*

## 5. MEMBRACIS FUSCATA, Fabricius.

*Membracis fuscata*, Fabr., Syst. Rhyng. p. 9, (1803); Fairmaire, A. S. E. F. (2 sér.), iv. p. 247, (1846).

Thorax foliaceous, rounded, fuscous; streak before the anterior margin and posterior band, white (*Fabr.*). This species does not seem to have been rediscovered since it was described by Fabricius. Reported from India.

## Genus HYPSAUCHENIA, Germar.

Silber. Rev. Ent. iii. p. 231 (1835) : Am. & Serv., Hist. Nat. Ins. Hém. p. 535 (1843) ; Fairmaire, A. S. E. F. (2 sér.) iv. p. 520 (1846) ; Stål, Hem. Afric. iv. p. 86 (1866) ; Ofvers. K. V.-A. Förh. p. 280 (1869).

Head almost triangular, trilobed at the extremity : prothorax a little shorter than the tegmina, without lateral horns, produced upwards in a compressed horn which is usually curved backwards and is bilobed at the tip : posterior process unilobed, slender, narrow at the base, narrower than the scutellum : tegmina free, slightly emarginate, extending much beyond the apex of the abdomen, very obliquely truncated at the apex, apical angle produced for some distance ; tibiæ simple.

## 6. HYPSAUCHENIA UNCINATA, Stål.

*Hypsauchenia uncinata*, Stål, Ofvers. K. V.-A. Förh. p. 283 (1869).

Obscurely ferruginous, ochraceous pubescent : dorsal horn of the pronotum bending a little forwards, posteriorly sublobate, acuminate and recurved at the apex ; tegmina punctured before the middle, pellucid behind the middle. ♀, long, 8 ; broad  $2\frac{1}{2}$  millims.

Reported from N. E. India : the Indian Museum possesses a specimen (mutilated) from the Nāga hills.

The anterior horn is much shorter and differently formed from other species of this genus : pronotum punctulate, furnished anteriorly with a compressed dorsal horn, somewhat shorter than the posterior process, bending a little forwards, posteriorly roundly amplified a little above the middle, apex slender, acuminate and much recurved ; posterior process somewhat elevated behind the middle : tegmina fairly densely reticulated behind the middle (Stål).

## 7. HYPSAUCHENIA HARDWICKII, Kirby.

*Centrotus hardwickii*, Kirby, Mag. N. H. ii. p. 21, f. 5 b (1829).

*Hypsauchenia hardwickii*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 520, t. 3, f. 20, 21 (1846) ; Walker, List Hom. B. M. ii. p. 631 (1851) ; J. L. S. Zool. x, p. 183 (1867).

Brownish black, sprinkled with short, decumbent, inconspicuous hairs ; legs (except the femora) paler than the rest of the body : pronotum minutely punctured, elevated above the head into a recurved quadrangular horn and terminating in a fork resembling a pair of concavo-convex, pedunculated, pointed leaves ; scutellum (posterior process) of the length of the body, punctured, acute and elevated into a rounded lobe, near the apex : tegmina naked, punctured, veined longitudinally (*Kirby*). Body long, 7.9 millims.

Reported from Nepál : the Indian Museum possesses specimens from Sikkim and Assam.



The *Hypsauchenia ballista* of Germar (Silb. Rev. Ent. iii. p. 231. 1835) *nec* Am. & Serv. (Hist. Nat. Ins. Hém. p. 535, t. 9, f. 5, 1843) is referred to *H. hardwickii* by Fairmaire (*l. c.* p. 520) and Am. & Serv.'s species *H. balista* is referred to the genus *Sphongophorus* from Mexico (*l. c.* p. 261). *S. balista*, Am. and Serv., differs from *H. ballista*, Germar, in the posterior process ending in an erect ensiform prolongation, which is wanting in *hardwickii* from India.

#### Genus LEPTOBELUS, Stål.

Hem. Afric. iv. p. 86 (1866) : Ofvers. K. V.-A., Förh. p. 280 (1869).

Frons without a basal lateral lobe, gradually narrowed : sides of the pectus unarmed : thorax with the disc elevated, the elevated part furnished on both sides with a slender horn, and posteriorly with a slender process, well apart from the body : scutellum elongate, longer than broad, gradually acuminate or much narrowed towards the apex, and with the apex slightly and narrowly obtusely or subsinuate truncated : exterior discoidal area of tegmina petiolated : wings with four apical areas : tibiae very rarely dilated (Stål).

#### 8. LEPTOBELUS DAMA, Germar.

*Centrotus dama*, Germar, Silbermann's Rev. Ent. iii. p. 258 (1835) : Fairmaire, A. S. E. F. (2 sér.) iv. p. 510 (1846), t. 3, f. 14 : Walker, List Hom. B. M. ii. p. 602 (1851).

*Leptobelus dama*, Stål, Berlin Ent. Zeitsch. p. 386 (1866) : Ofvers. K. V.-A. Förh. p. 284 (1869).

Black : thorax, posteriorly, with white scales ; furnished with a short slender process on the dorsum anteriorly, turning upwards, armed at the apex on both sides with a spine which is produced outwards, and inflexed at the apex : scutellum elongated, spinose, white at the base : exterior discoidal area of corium petiolated (*Fairm.*). Body long, 9 millims.

Reported from India : the Indian Museum possesses a specimen from the Khasiya hills.

#### 9. LEPTOBELUS GAZELLA, Fairmaire.

*Centrotus gazella*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 510 (1846) : Walker, List Hom. B. M. ii. p. 602 (1851).

*Leptobelus gazella*, Stål, Berlin Ent. Zeitschr. x. p. 386 (1866) : Ofvers. K. V.-A. Förh. p. 284 (1869).

Cærulean black, thorax elevated in the middle, the elevated part trispinose, spines not inflexed, posteriorly not scaly with white. Closely allied to *L. dama*, from which it differs by its smaller size, the lateral spines shorter proportionately and slightly turned up : the prothorax is of

a bluish black without a white patch posteriorly : the scutellum is elongated, white at the base : the tegmina are transparent, more yellow, black at the base ; exterior discoidal area of corium, petiolated. Body long 8 millims.

Reported from India.

#### 10. LEPTOBELUS PALLIPES, Stål.

*Leptobelus pallipes*, Stål, Ofvers. K. V.-A. Förh. p. 284 (1869).

Black, distinctly punctulate : thorax anteriorly without a dorsal process : sides of thorax and pectus, also base of scutellum, densely ochreous-sericeous : tegmina sordidly vinaceous, base of clavus and entire costal area and radial area at the base and outwards beyond the middle, black, punctured : lateral horns of pronotum, slender, moderate, gradually acuminate, straight, turning outwards, above unicarinate, beneath bicarinate ; posterior process slightly curved towards the base, thence straight, distant from the scutellum : exterior discoidal area of corium petiolated ; feet yellow-ferruginous. ♀ body long  $5.5\frac{1}{2}$  : breadth, 2 millims.

Reported from India.

Very like *L. curvispinus*, Stål, (Ceylon), lateral horns of thorax shorter, more slender, turning outwards ; very little upwards ; posterior process not reaching the apex of the scutellum and the frons narrower at the apex (Stål).

#### 11. LEPTOBELUS VARIUS, Walker.

*Centrotus varius*, Walker, List Hom. B. M. Suppt. p. 162 (1858).

*Leptobelus varius*, Stål, Ofvers. K. V.-A. Förh. p. 285 (1869).

Black, minutely punctured : head somewhat excavated between the eyes ; pronotum keeled, unarmed on each side, with a smooth shining spot on each side in front, shoulders somewhat acute : posterior process slender, acute, undulating, testaceous in the middle, not extending beyond the tip of the abdomen : legs piceous : knees, tarsi and tips of the tibiæ tawny : tegmina punctured towards the base, with various vitreous marks hindward, and with a large vitreous patch near the tip of the costa (*Walker.*) Body long  $4\frac{1}{4}$  : exp. teg.  $8\frac{1}{2}$  millims.

Reported from Burma.

The species of this genus appear to be distributed as follows :—

A. Thorax furnished on the dorsum anteriorly with a short, slender process turning upwards and armed at the apex on both sides with a spine produced outwards, exterior discoidal area of corium petiolate : *L. dama*, *L. gazella*.

B. Thorax anteriorly without the dorsal process, either cornuted or ridged above the lateral angles.

B. a. Posterior process of thorax distinctly curved towards the base : exterior discoidal area of corium petiolate : *L. curvispinus*, *L. pallipes*.

B. b. Posterior process of thorax straight, subundate, reaching the apical part of the scutellum, discoidal area of corium sessile, gradually much narrowed towards the base : *L. varius*, *L. auriculatus*, (Stål).

## 12. LEPTOBELUS SCUTELLARIS, Fabricius.

*Centrotus scutellaris*, Fabr., Syst. Rhyng. p. 19 (1803) : Germar, Silb. Rev. Ent. iii. p. 257 (1835) : Fairmaire, A. S. E. F. (2 sér.) iv. p. 510 (1845) : Walker, List Hom. B. M. ii. p. 602 (1851).

Stål, in index to Hem. Fabr. (ii. p. 115), places a query after this species ; and all that seems to be known is that it is reported from India.

## 13. LEPTOBELUS PARIA, Fairmaire.

*Centrotus paria*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 513 : (1846) : Walker, List Hom. B. M. ii. p. 609 (1851).

Ferruginous : eyes projecting : horns a little divaricate, slender, acute, compressed : posterior process very slender, bordered on each side by the scutellum which is broad and white, as long as the abdomen : sides of the pectus white : feet yellowish : tegmina transparent (*Fairm.*) Long 6 millims.

Reported from India.

## Genus XIPHOPEUS, Stål.

Hem. Afric. iv. p. 87, 91 (1866) : Ofvers. K. V.-A. Förh. p. 281 (1869).

Frons prominulous below in the shape of a tubercle ; thorax cornuted above the lateral angles ; posterior process much distant from the scutellum and abdomen, much curved from the base or geniculated near the base ; beneath, armed with small spines, at least towards the base, not dilated in the middle beneath ; tegmina with five apical and two discoidal areas, none of which are petiolated : wings with four apical areas : tibiæ simple or very slightly dilated (Stål).

## 14. XIPHOPEUS PILOSUS, Walker.

*Centrotus pilosus*, Walker, List Hom. B. M. ii. p. 606 (1851).

*Xiphopeus pilosus*, Stål, Ofvers. K. V.-A. Förh. p. 285 (1869).

Ferruginous, very thickly clothed with sordid white down : head punctured, short, transversely subfusiform, a little narrower than the thorax, with a metallic lustre in front, nearly twice as broad as long : face small : thorax punctured, deep in front, partly black, rising almost vertically from the head, slightly ridged, shoulders obtusely angular,



somewhat prominent : horns above rather long, broad, irregularly prismatic, slightly diverging and inclined forwards ; tips more diverging, almost trifurcate, slightly amplified ; inner side and outer side much broader than the hinder side, angles slightly serrated ; of the three forks or angles at the tip, the fore one is slightly obtuse, the middle one acute, and the hind one rectangular ; hind horn stout and vertical for a short space from the base, then forming a right angle and extending backward much beyond the tip of the abdomen ; hind part tawny, slender, tapering, very slightly undulating, with an acute black tip : pectus and abdomen piceous : legs tawny : a brown spot on the hind angle of each tegmen : veins tawny, here and there, brown (*Walker*). Body long  $4\frac{1}{4}$  : exp. teg.  $9\frac{1}{2}$  millims.

Reported from N. India.

#### Genus ACANTHOPHYES, Stål.

Hem. Afric. iv. p. 87, 89 (1866) ; Ofvers. K. V.-A. p. 281 (1869).

Thorax much elevated between the lateral angles, very often cornuted above the same angles ; posterior process distant from the scutellum, bisinuate beneath, more or less amplified or lobed in the middle, between the sinus, with the amplified part reaching the dorsum of the abdomen or the apex of the scutellum : tegmina with five apical, two discoidal areas : wings with four apical areas : tibiæ simple (Stål).

#### 15. ACANTHOPHYES CAPRA, Fabricius.

*Membracis capra*, Fabr., Ent. Syst. Suppt. p. 514 (1798).

*Centrotus capra*, Fabr., Syst. Rhynch. p. 20 (1803).

*Acanthophyes capra*, Stål, Hem. Fabr. ii. p. 50 (1869).

Body altogether fuscous, immaculate : horns of thorax, large, thick, obtuse ; thorax posteriorly short, emarginate : tegmina fuscous (*Fabr.*). Ferruginous black or ferruginous, remotely flavescent-grey-sericeous, two small basal spots on scutellum and sides of pectus very densely sericeous : lateral horns of thorax depressed, truncated, bicarinate above. ♀ : long with tegmina  $6\frac{1}{2}$  ; thorax broad, 3 ; exp. thoracic horns,  $4\frac{1}{2}$  millims.

Head between the eyes a little shorter than broad, beneath the eyes abruptly very much narrowed ; frons gradually slightly narrowed, subtruncate, freely produced downwards for a distance : thorax punctured, armed on both sides anteriorly above the lateral angles with a depressed horn, very slightly narrowed towards the apex, truncated at the apex, bicarinate above and below ; anterior apical angle of the horns round, posterior somewhat acute ; posterior process distinctly carinate, very broadly sinuated in the middle above, a little amplified beneath in the middle, reaching the apex of the scutellum, very slightly decurved

towards the apex : tegmina fuscous-ferruginous or ferruginous-grey, punctured at the base (Stål).

Reported from Tranquebar, India.

Genus LEPTOCENTRUS, Stål.

Hem. Afric. iv. p. 87, 90 (1866) : Ofvers. K. V.-A. Förh. p. 281 (1869).

Frons more or less prominulous downwards : thorax cornuted above the lateral angles ; posterior process, slender, three-cornered, acute, emitted a little before the posterior margin of the thorax, altogether distant from scutellum and abdomen, not unless posteriorly touching the interior margin of the tegmina, not sinuated beneath nor amplified in the middle : scutellum emarginate at the apex, moderate : tegmina with five apical, two discoidal areas, none of them petiolated : wings with four apical areas : tibiæ simple.

16. LEPTOCENTRUS TAURUS, Fabricius.

*Membracis taurus*, Fabr., Syst. Ent. p. 676 (1775) : Spec. Ins. ii. p. 317 (1781) : Mant. Ins. ii. p. 244 (1787) : Ent. Syst. iv. p. 14 (1794) ; Olivier, Enc. Méth. vii. p. 665 (1792).

*Membracis rupicapra*, Fabr., Ent. Syst. Suppt. p. 514 (1798).

*Centrotus rupicapra*, Fabr., Syst. Rhyng. p. 18 (1803).

*Centrotus taurus*, Fabr., Syst. Rhyng. p. 20 (1803) ; Germar, Mag. iv. p. 32 (1821) ; Silb. Rev. Ent. iii. p. 257 (1835) : Fairmaire, A. S. E. F. (2 sér.) iv. p. 510 (1846) ; Walker, List Hom. B. M. ii. p. 602 (1851) ; ibid. Suppt. p. 158 (1858) ; J. Linn. S. Zool. i. p. 93 (1856) ; ibid. p. 163 (1857).

*Membracis tricornis*, Hardwicke, Zool. Journ. iv. p. 114, t. Suppt. 30, fig. c. d. f. (1828).

*Centrotus terminalis*, Walker, List Hom. B. M. ii. p. 604 (1851).

*Centrotus vicarius*, Walker, l. c. p. 605 (1851).

*Leptocentrus taurus*, Stål, Ofvers. K. V.-A. Förh. p. 491 (1862) ; Berlin Ent. Zeitsch. x. p. 386 (1866) : Hem. Fabr. ii. p. 50 (1869).

Fairmaire makes *M. tricornis*, Hardwicke, a synonym for *L. taurus*, Fabr., to which Walker adds his own *C. vicarius* and *C. terminalis*, and Stål adds *C. rupicapra*, Fabr.

Head fuscous, eyes castaneous, a white spot before the eyes : thorax fuscous with two stout horns, a little arched, produced posteriorly, filiform : sides of pectus white : wings obscure : body fuscous (*M. taurus*, Fabr.). Body small, fuscous ; thorax with three horns, the lateral thicker, obtuse or rather truncate, subdentate ; the intermediate, posterior, recurved : tegmina fuscous hyaline ; wings whitish (*M. rupicapra*, Fabr.). Fairmaire remarks that *C. taurus* is black with the scutellum and sides of the pectus white and the tegmina with the costa fuscous. Hardwicke describes his *M. tricornis* as head, thorax, and body black ;

wings ash-grey, longer and broader than the body, and incumbent: thorax three-horned, two of which are placed in front behind the eyes, about as long as the thorax, strong, erect and curved outwards; the third horn rises from the posterior margin of the thorax, extending in a gentle arch the whole length of the body and tapering to the apex. Stål notes that the type has the lateral margins and apical spine of the scutellum sordid whitish. Walker's *C. terminalis* is thus described: "Black, clothed with tawny hairs; head and pronotum roughly punctured: head convex very short, transversely subfusiform, a little narrower than the pronotum, undulating along the hind border, retuse in front, on each side of the face whose hind border is semicircular and occupies much less than half the length of the face; clypeus prominent, retuse: pronotum thick in front rising vertically above the head, indistinctly ridged; shoulders very obtusely angular, not prominent; above them are two long, stout, prismatic, diverging, acute horns which are curved backwards, especially towards the tips; their sides are slightly concave, their inner and outer sides are of equal breadth, their hinder side is narrower; behind them the pronotum is armed with a long, slender, smooth, acute triangular horn which is slightly curved downwards and extends to the tip of the abdomen: abdomen above with hoary reflections: tibiæ pitchy; hind tarsi tawny: wings very pale lurid; a narrow pale brown streak on the fore-border near the tip of each tegmen; two discoidal areolas; veins tawny: wings colourless, veins black." Body long 6.8 millims.

Fairmaire notes that he cannot separate from this species smaller ones of which the horns are very acuminate and hardly recurved, and others in which the horns are relieved and oblique. *M. vicarius*, Walker, is one of those in which the horns are short.

Reported from India: the Indian Museum possesses specimens from Calcutta, Sikkim.

#### 17. LEPTOCENTRUS REPONENS, Walker.

*Centrotus reponens*, Walker, List Hom. B. M. ii. p. 604 (1851): J. L. S. Zool. x. p. 183, (1867).

*Centrotus antilope*, Stål, Freg. Eug. Resa, Ins. p. 284 (1859).

*Leptocentrus antilope*, Stål, Ofvers. K. V.-A. Förh. p. 727 (1870).

Fuscous ferruginous: rudely punctured, sparingly covered with whitish down, head and thorax anteriorly more densely clothed; thorax anteriorly subreclinately sloped, armed on both sides with a horn, strong, long, produced somewhat upwards, recurved towards the apex, three-cornered; posterior process from its base distant from the abdomen, somewhat curved at the base, thence straight, equally thick, extending somewhat beyond the apex of the abdomen, three cornered



with a high median ridge: tegmina weakly fuscous-hyaline, veins fuscous. Size almost the same as that of *L. taurus*, but differs in being longer, proportionately narrower, anterior horns longer, more produced upwards, scutellum concolorous (Stål). Body long 9: broad 5 millims.

Reported from New Guinea, Timor, Philippines, Ceylon, India: the Indian Museum possesses specimens from Calcutta.

#### 18. LEPTOCENTRUS SUBSTITUTUS, Walker.

*Centrotus substitutus*, Walker, List Hom. B. M. ii. p. 605 (1881).

In structure like the preceding: horns of thorax short as in var. *vicarius*, Walker, of *L. taurus*; pectus with a thick patch of pale yellow down on each side in front; legs black; tarsi pitchy; hind tarsi tawny; wings black; tips colourless; veins tawny. Body long  $6\frac{1}{4}$ : wings long  $12\frac{1}{2}$  millims. (*Walker*).

Reported from N. Bengal.

#### Genus CENTROTYPUS, Stål.

Hem. Afric. iv. p. 88 (1866): Ofvers. K. V.-A. Förh. p. 281 (1869).

Frons gradually narrowed from the base, without a lobe on both sides at the base: posterior process of thorax not sinuated on each side from the base to the scutellum, never distant from the scutellum, gradually narrowed, covering the whole or almost the whole of the scutellum; dorsum of thorax distinctly keeled, the keel not (or very obsoletely) continued forward through the thorax, which instead of a keel has a somewhat smooth line: sides of scutellum not prominulous, scutellum not or only a little, seldom twice, as broad as the base of the posterior process of the thorax: tegmina with five entire, oblong, apical areas; costal area punctured at the base, costal and radial areas abbreviated at the same distance or almost so from the base (Stål).

#### 19. CENTROTYPUS FLEXUOSUS, Fabricius.

*Membracis flexuosa*, Fabr., Ent. Syst. iv. p. 12 (1794).

*Centrotus flexuosus*, Fabr., Syst. Rhyng. p. 18 (1803): Fairmaire, A. S. E. F. (2 sér.) iv. p. 516 (1846): Walker List Hom. B. M. ii. p. 611 (1851).

*Centrotus anchorago*, Guérin, Icon. Règne Anim. t. 59, f. 4 (1829-43).

*Centrotypus flexuosus*, Stål, Hem. Fabr. ii. p. 51 (1869): Ofvers. K. V.-A. Förh. p. 286 (1869).

Thorax punctured, cœrulean; with a stout horn on both sides, flat, acute, black, a little flexuose, posteriorly produced in a spine, longer than the abdomen: wings black, a spot on the slender margin whitish: body black (*M. flexuosa*, Fabr.).

Cœrulean black : lateral horns of thorax long, somewhat recurved, scarcely turning upwards, above unicarinate, hardly broader than the median part of the posterior process, acute : tegmina subvinaceous, ferruginous towards the apex, with the base and the broad costal limbus beyond the middle, blackish (Stål) ♀. Body long 10 : breadth of pronotum  $3\frac{3}{4}$  : exp. horns of thorax  $8\frac{1}{2}$  millims.

Reported from India : the Indian Museum possesses specimens from Sikkim.

## 20. CENTROTYPUS ASSAMENSIS, Fairmaire.

*Centrotus assamensis*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 517 (1846).

*Centrotus costalis*, Walker, Ins. Saunders. Hom. p. 27 (1858).

*Centrotypus assamensis*, Stål, Ofvers. K. V.-A. Förh. p. 286 (1869) : Distant, J. A. S. B. xlviii. (2), p. 38 (1879).

Greenish black, blue on the horns : allied to *C. flexuosus*, Fabr. thoracic horns less dilated, ridged before and behind, more relieved : tegmina yellow, pellucid, with the external margin blackish brown, a brown patch at the internal angle (*Fairm.*). Long 11 millims.

Reported from Assam and Tenasserim ; the Indian Museum possesses specimens from the latter locality.

## 21. CENTROTYPUS OBESUS, Fairmaire.

*Centrotus obesus*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 518 (1846) : Walker, List Hom. B. M. ii. p. 612 (1851) : Stål, Berlin Ent. Zeitsch. x. p. 386 (1866).

*Centrotus malleator*, Walker, List l. c. p. 612 (1851), Java.

*Centrotus malleolus*, Walker, List l. c. p. 613 (1851), Java.

*Centrotus malleus*, Walker, List l. c. p. 613 (1851), Ceylon.

*Centrotypus obesus*, Stål, Ofvers. K. V.-A. Förh. p. 286 (1869).

Cœrulean-black, shining : prothorax tumid and rounded anteriorly and between the shoulders (especially in ♀), deeply punctured : horns conical, slightly projecting, almost horizontal : posterior process, sinuated, slender, slightly curved below at the tip, longer than the abdomen : scutellum white, short ; basal half of tegmina of a transparent yellow, rest brown, external border blackish (*Fairm.*). Long 8-10 millims.

Reported from Java, Ceylon, India.

## Genus COCCOSTERPHUS, Stål.

Hem. Fabr. ii. p. 51 (1869).

Body small, obovate : head with the eyes equal in breadth to the anterior part of the thorax, with the eyes, deflexed, somewhat transverse, slightly inflexed beneath the eyes, frons a little elevated, not freely prominent, with the apical margin a little prominu-

lous : ocelli twice as distant from each other as from the eyes : thorax moderately convex, unarmed on both sides anteriorly, gradually narrowed behind the slightly prominulous lateral angles and gradually passing into the posterior process ; the posterior process entire on both sides at the base, not sinuated, gradually acuminate, straight, slightly deflexed at the apex, equalling the apex of clavus, somewhat highly ridged, much depressed in the middle. No complete scutellum : mesonotum furnished on both sides at the apex with a spinule turning backwards. Tegmina short, not extending beyond the apex of the abdomen, gradually somewhat amplified towards the apex which is obliquely rounded, opaque and coriaceous at the base ; exterior vein of clavus united with the commissure at some distance beyond the middle ; corium emitting the ulnar and radial veins from the base, ulnar vein somewhat forked before the middle of the corium, two discoidal areolas or, if the areola behind the fork of the ulnar vein be included, three ; the exterior discoidal areola stylated, stylus separating the interior (or intermediate) discoidal areola from the first apical area, five apical areas. Wings with three apical areolas. Feet moderate, tibiae prismatic, anterior a little depressed : anterior trochanters unarmed within.

A curious genus allied to *Gargara*, Stål ; but very distinct in having the thorax behind the lateral angles gradually passing into the posterior process which has no sinus at the base ; there is no produced complete scutellum, but the mesonotum is armed at the apex with two very distant spines (Stål).

## 22. COCCOSTERPHUS MINUTUS, Fabricius.

*Membracis minuta*, Fabricius, Ent. Syst. Suppt. p. 514 (1798).

*Centrotus minutus*, Fabricius, Syst. Rhynch. p. 22 (1803).

*Scaphula* (?) *minuta*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 495 (1846) ; Walker,

List Hom. B. M. ii. p. 589 (1851).

*Coccosterphus minutus*, Stål, Hem. Fabr. ii. p. 51 (1869).

Minute : head and thorax black, scabrous with elevated dots : thorax subunarmed, produced posteriorly, attenuated, a little elevated before the apex, as long as the abdomen : tegmina obscurely whitish, somewhat spotted fuscous, black at the base ; wings shorter, hyaline : body black (*Fabr.*). Black, flavescent-greyish-sericeous : head, thorax and tegmina remotely sprinkled with somewhat large granules : thorax furnished with a ridge or keel, obsolete anteriorly, very elevated in the posterior process, in its medium depressed part interrupted : tegmina palely greyish-flavescent, subpellucid, obsoletely dotted with white, veins here and there infuscate, granules and almost third basal part, black ; black part punctured ; ulnar vein running through this part greyish-flavescent (Stål).

♂. Body long  $3\frac{1}{4}$  : broad 2 millims.

Reported from E. India, Tranquebar.



## Subfamily DARNINA, Stål.

*Darnida*, Stål, *Ofvers. K. V.-A.* p. 556 (1867); p. 250 (1869).

## Genus HEMIPTYCHA, Germar (in part).

Fairmaire, *A. S. E. F.* (2 sér.) iv. p. 312 (1846): Stål, *Ofvers. K. V.-A. Förh.* p. 557 ((1867), p. 250 (1869).

Thorax without an impression above the lateral angles, much elevated anteriorly, furnished on both sides with a long horn, strong, curved, acute, turning upwards, reaching with the lateral margins of the posterior process the longitudinal vein of the clavus, covering part of the apex of the clavus and narrow interior posterior part of the corium, apical half or more very slightly deflexed; entire dorsum tectiform or compressly acute, sinuated above beyond the middle, behind the sinus gradually decreasing in height, equal to or extending a little beyond the apex of the tegmina; head obtusely triangular: ocelli a little more distant from the eyes than from each other.

## 23. HEMIPTYCHA CRUX, Linnæus.

*Cicada crux*, Linn., *Syst. Nat.* (ed. 10) i. p. 435 (1758): Mus. Lnd. Ulr. p. 154 (1764).

*Hemiptycha crux*, Stål, *Berlin Ent. Zeitsch.* x, p. 389 (1866).

Fuscous-testaceous: thorax black, anteriorly obsoletely spinkled testaceous, behind the lateral horns broadly margined with yellow, this yellow margin narrowed backwards, extended beyond the middle of the posterior produced part: tegmina fuscous. Thorax distinctly punctulate, furnished with a very strong and long horn above the lateral angles, compressed, turning outwards and moderately upwards, at the apex obliquely truncated, anteriorly rounded, at the apex posteriorly acuminate, slightly amplified towards the tip; posterior produced part gradually acuminate, extending a little beyond the tip of the tegmina; apex itself very slightly recurved: dorsum seen from the side somewhat straight and with a distinct ridge, lateral margins straight (Stål). ♀, body long 18; exp. horns of thorax 17 millims.

Reported from India (*Linn.*).

## Genus SCAPHULA, Fairmaire.

*A. S. E. F.* (2 sér.) iv. p. 494 (1846).

Head triangular, rounded at the tip: eyes very broad, prominent, ocelli contiguous: prothorax smooth, sometimes elevated, slightly rounded posteriorly: tegmina free, with posterior veins waved, one small discoidal; the internal extremity sometimes slightly covered by the prothorax: posterior tarsi longer than the anterior (*Fairm.*).

## 24. SCAPHULA SEMIATRA, Fairmaire.

*Scaphula semiatra*, Fairmaire, A. S. E. F. (2 sér.) iv. p. 494, t. iii. f. 18, 19; t. vii, f. 20 (1846); Walker, List Hom. B. M. ii. p. 589 (1851).

Brownish black, shining; prothorax somewhat elevated in the middle, terminated posteriorly by a defined, rounded border; tegmina free, dull black, posterior third transparent: abdomen beneath, anterior feet, knees, and tarsi yellowish; posterior feet blackish (*Fairm.*) Body long 6 millims.

Reported from Coromandel?

## Family JASSIDÆ, Stål.

*Jassida*, Stål, Hem. Afric. iv. p. 82 (1866); Fieber, Kat. p. 8 (1872); Rev. Mag. Zool. (3 sér.) iii., pp. 337, 386, (1875).

## Subfamily PAROPINA, Fieber.

*Paropida*, Fieber, Kat. p. 7 (1872); Rev. Mag. Zool. (3 sér.) iii, p. 384 (1875): *Paropides*, Sign. A. S. E. F. (5 sér.) ix, p. 47 (1879).

## Genus SIGNORETIA, Stål.

Freg. Eug. Resa, p. 289 (1859).

Body elongate, subparallel: head with the eyes broader than the thorax, round in front, semilunate on the vertex, subconcave, furnished posteriorly with a high transverse ridge; frons large, convex, with a much elevated longitudinal ridge; ocelli placed in a small excavation in the margin of the base of the frons at the eyes: thorax shorter than broad, parallel, anteriorly semicircularly rounded and produced between the eyes, rounded behind, posteriorly convex, anteriorly semicircularly depressed, where it is furnished with two ridges before the apex, lying close to each other: scutellum small, triangular: tegmina longer than the abdomen with the longitudinal veins towards the apex, once joined by the transverse nervures, the intracostal longitudinal vein forked behind the middle: feet moderate, posterior tibiæ three-cornered, angles remotely spinose. Allied to *Paropia*: ocelli nearer the eyes, frons convex, ridged, thorax differing in shape, the scutellum very small (Stål).

## 25. SIGNORETIA MALAYA, Stål.

*Thamnotettix malaya*, Stål, Ofvers. K. V.-A. Förh. p. 192 (1855).

*Signoretia malaya*, Stål, Freg. Eug. Resa, p. 290, t. 4, f. 9, a. b. (1859).

Virescent-whitish, densely and roughly punctured; tegmina virescent whitish hyaline; entire clavus, space between the costa and the

second longitudinal vein, also other veins on both sides, fairly roughly punctured (Stål). Long 7; broad,  $1\frac{1}{2}$  millims.

Reported from Malacca, Tenasserim (?).

#### Subfamily LEDRINA, Stål.

*Ledrina*, Stål, Ofvers. K. V.-A. Förh. p. 731 (1870): *Scarida*, Fieber, Kat. p. 7, (1872); Rev. Mag. Zool. (3 sér.), iii, p. 386, (1875).

#### 26. LEDRA SERRULATA, Fabricius.

*Ledra serrulata*, Fabr., Syst. Rhyng. p. 24 (1803): Stål, Hem. Fabr. ii, p. 58, (1809).

Greyish or flavescent-greyish: body beneath and feet weakly testaceous flavescent or testaceous whitish: tegmina greyish pellucid behind the middle, near the base with a pallescent, broad, obsolete band; wings sordidly hyaline: the dorsum of the abdomen flavescent-sanguineous: thorax elevated posteriorly and furnished on both sides with a lobe, erect, produced forwards, crenulated posteriorly on the margin. Sometimes with two interrupted bands on the inferior part of the head and certain median marks on the thorax, black (Stål). ♀ Body long, 18; broad 5 millims. Stature of *L. aurita*, Linn. (Britain) head more roundly produced, lobes of thorax longer. Head somewhat shorter than the thorax, gradually distinctly amplified through a short space before the eyes, thence abruptly angulated and anteriorly much rounded, the ocellar tract impressed, the impressed part amplified forwards and gradually merging in the anterior disc, anteocular part remotely sprinkled with distinct granules. Lateral margins of thorax parallel at the apex, thence somewhat divergent backwards, two parallel ridges behind the middle anteriorly slightly divergent, obtuse, minutely tuberculate, and towards the sides a lobiform crest, very high, slightly bending forwards, remotely granulate, posteriorly crenulate. Scutellum gradually transversely depressed towards the middle, before the middle sprinkled with granules towards the sides, posteriorly much elevated, the elevated part posteriorly black and granulate. Tegmina gradually slightly amplified beyond the middle, thence rounded outwards: almost entire clavus and corium towards the base punctured and sprinkled with granules at intervals, veins here and there infusate. Tibiæ above sparingly granulate.

Reported from Malacca, Tranquebar.

#### 27. LEDRA MUTICA, Fabricius.

*Ledra mutica*, Fabricius, Syst. Rhyng. p. 25, (1803): Stål, Hem. Fabr. ii, p. 59, (1809).

*Ledra fornicata*, Walker, List Hom. B. M. iii, p. 815, (1851).

*Ledra carinata*, Walker, List l. c. p. 815, (1851).



Greyish mingled with fuscous or weak ferruginous and granulated, beneath palely sordid flavescent : head and thorax equal in length, the head obtusely angulated at the apex, the thorax posteriorly quadricarinate : dorsum of abdomen weakly sanguineous : clavus sometimes marked anteriorly with a large pale spot : wings sordid hyaline, sanguineous at the base. ♀, body long, 18 ; broad  $4\frac{3}{4}$  millims.

Allied to *L. dilatata*, Walker, but narrower, head longer. Head very obtusely tectiform, much produced, furnished with a median wrinkle, running through it, and posteriorly with four longitudinal wrinkles, the exterior a little oblique ; somewhat roundly amplified before the eyes, thence gradually obtusely angulated towards the apex, gradually very obtusely roundly-narrowed, sprinkled with granules and small tubercles. Thorax hardly narrowed forwards, subsinuate before the middle on both sides, behind the middle gradually elevated backwards, remotely sprinkled with granules, posteriorly furnished with four parallel ridges. Scutellum with the apical part much elevated and longitudinally birugose, the wrinkles (*rugæ*) granulated. Tegmina gradually a little amplified beyond the middle, thence rounded externally, behind the middle more pellucid, towards the base sprinkled at intervals with granules, greyish, veins more obscure, here and there infusate or palely ferruginous. Tibiæ above sprinkled with some granules (Stål).

Reported from Tranquebar, N. India, N. Bengal.

## 28. LEDRA DILATATA, Walker.

*Ledra dilatata*, Walker, List Hom. B. M. iii, p. 811, (1851) : Stål, Ofvers, K. V.-A. Förh. p. 495, (1862) ; Hem. Fabr. ii, p. 59, (1869).

*Ledra scutellata*, Walker, l. c. p. 812, (1851).

*Ledra plana*, Walker, l. c. p. 812, (1851).

Closely allied to *L. mutica*, Fabr. Testaceous, paler beneath : head and prothorax, with ferruginous tubercles : head broader than the thorax, very slightly arcuated, anterior margin rounded, each side somewhat angulated, hinder margin very slightly sinuate, weakly tricarinate, the lateral ridges short and oblique ; its length hardly half its breadth : thorax convex on the disc, furrowed across, very slightly convex along the anterior margin, with a pale band on the disc, which has five slight ridges, the middle one short : posterior margin concave in the middle, convex on each side : scutellum gibbous with two slight crests towards the tips : abdomen red above : tegmina whitish, very convex along the foreborders towards the tips ; veins pale ferruginous with a few piceous tubercles towards the base : wings colourless : tibiæ with piceous tubercles, slightly widened and fringed (*Walker*). Body long  $10\frac{1}{2}$  : teg. 25 millims.

Reported from E. India.

## 29. LEDRA DORSALIS, Walker.

*Ledra dorsalis*, Walker, List Hom. B. M. iii, p. 810, (1851); Stål, Ofvers, K. V.-A. Förh. p. 495, (1862).

Ferruginous, testaceous beneath, head a little broader than the thorax: very slightly arched, rounded in front, obtusely angular on each side, slightly sinuate on the posterior margin; its length hardly half its breadth; three broad, low, rounded ridges on the vertex, the side pair oblique; face with three black stripes corresponding to the ridges above: shield roughly punctured, slightly convex in front, very concave on the hind border, armed with six crests, outer pair irregular, horizontal, and oblique; next pair vertical, very high, marked with black, convex above, perpendicular and forming right angles behind; inner pair slight, interrupted with two black dots on each towards the hind border, scutellum convex: abdominal appendages short: legs testaceous: tegmina ferruginous, tuberculate, especially towards the base, almost colourless towards the tips: wings almost colourless (*Walker*). Body long 21; teg.  $37\frac{1}{2}$  millims.

Reported from Silhat.

The following three species are of doubtful position:—

## 30. LEDRA PUNCTATA, Walker.

*Ledra punctata*, Walker, List Hom. B. M. iii, p. 824, (1851).

Testaceous, paler beneath: head and thorax broad, roughly punctured; head very short-conical, narrower than the thorax, not arched, hardly ridged, very slightly concave along the hind border, with irregular whitish reticulations; its length less than half its breadth; face with a furrow along each side: shield green on the disc, with irregular whitish reticulations in front and on each side, where it is slightly widened and angular: legs pale testaceous: tegmina almost colourless, punctured from the base to the tips, tinged with pale green and along the borders with pale brown; tips darker brown; veins very few: wings white (*Walker*). Body long,  $7\frac{1}{4}$ ; teg.  $15\frac{1}{2}$  millims.

Reported from Malabar.

## 31. LEDRA LINEATA, Walker.

*Ledra lineata*, Walker, List Hom. B. M. iii, p. 830 (1851).

Stramineous, fusiform: head and thorax flat; head almost smooth, conical, almost as broad as the thorax, not arched nor ridged, with a slight rim, hardly sinuate along the hind border; its length less than its breadth; face flat on the disc, with very oblique and indistinct striæ on each side: shield minutely striated across; scutellum with a

slightly arched transverse suture near the tip : tegmina whitish, semi-transparent ; veins bordered with a darker colour ; wings colourless (*Walker*). Body long,  $7\frac{1}{4}$  : teg.  $10\frac{1}{2}$  millims.

Reported from N. India.

### 32. LEDRA PUNCTIFERA, Walker.

*Ledra punctifera*, Walker, List Hom. B. M. Suppt. p. 249 (1858).

Greenish-testaceous (pale green ? when alive) ; very minutely punctured, whitish testaceous beneath : head flat, short, conical, very slightly impressed on each side above, and with a very slight keel beneath : thorax with a very slight impression on each side : tegmina with ramose veins and with a black point in each disc towards the hind border : wings vitreous (*Walker*). Body long,  $14\frac{1}{2}$  : teg. 25 millims.

Reported from Darjeeling.

### Genus LEDROPSIS, White.

A. M. N. H. xiv, p. 425 (1844).

Head with its prolongation longer than wide, parallel in front of the eyes, as wide as the thorax, then gradually curved to the tip, which is somewhat obtuse ; ocelli on the same line with the front of the eyes and rather more distant from each other than from the eyes : eyes large but not very prominent ; prolongation hollowed out beneath, with a spear-shaped elevated ridge running down the middle, the base of which, on the face between the eyes, is hollowed out : antennæ spring from a depression in front of the eyes beneath, 3-jointed, the terminal joint ending in a longish bristle : thorax rounded in front, very deeply notched behind, the posterior angles truncately rounded : tegmina with many inclosed cells at the end, the veins robust : body elongate, margined beneath : tibiæ of posterior feet not dilated, serrated behind (*White*).

### 33. LEDROPSIS OBLIGENS, Walker.

*Ledra obligens*, Walker, List Hom. B. M. Suppt. p. 251 (1858).

*Ledropsis obligens*, Stål, Ofvers. K. V.-A. Förh. p. 495 (1862).

Reddish, very elongate-subfusiform, testaceous beneath : head convex, elongate-conical, much longer than broad ; under side concave, with a very broad border, the middle compartment lanceolate, black towards the tip of the vertex : thorax convex : abdomen compressed, with a dorsal ridge : tegmina tawny, reticulated ; veins very numerous with some whitish marks : wings greyish-vitreous (*Walker*). Body long  $12\frac{1}{2}$  ; teg.  $16\frac{1}{2}$  millims.

Reported from India ?



Genus *TITURIA*, Stål.

Ofvers. K. V.-A. Förh. p. 158 (1865); Hem. Afric. iv. p. 102 (1866).

Body large, oblong: head foliaceous, clypeated, triangular, rounded at the apex, produced forwards and a little downwards, vertex flat; frons narrow, flat: face beneath the eyes, abruptly much narrowed, thence gradually narrowed, margins very slightly amplified: eyes small: ocelli placed behind the middle of the vertex between the eyes, more distant from the eyes than from each other: thorax and vertex in the same plane, somewhat sloped, the former sexangular, angulately amplified on both sides, lateral margins acute, anterior margin straight, posterior margin slightly sinuated: scutellum triangular: tegmina coriaceous, densely punctured, tectiform, reaching the apex of the abdomen, clavus very broad in the middle, corium triangular, obliquely or roundly truncated behind the clavus; veins irregularly anastomosed towards the apex, less elevated: feet somewhat short: anterior coxæ free; last tibiæ remotely dentated above. Allied to *Petalocephala*, (Stål).

34. *TITURIA PLANATA*, Fabricius.

*Membracis planata*, Fabr., Ent. Syst. iv. p. 11 (1794).

*Ledra planata*, Fabr., Syst. Rhyng. p. 25 (1803).

*Epiclines planata*, Am. & Serv., Hist. Nat. Ins. Hém. p. 578 (1843); Walker, List Hom. B. M. iii. p. 831 (1851).

*Epiclines hebes*, Walker, Ins. Saund. Hom. p. 100 (1858).

*Petalocephala planata*, Stål, Ofvers. K. V.-A. Förh. p. 501 (1862).

*Petalocephala expansa*, Stål, Ofvers. l. c. p. 158 (1865).

*Tituria planata*, Stål, Hem. Fabr. ii. p. 59 (1869).

Clypeus flat, triangular, entirely virescent, eyes oblong, fuscous: pronotum smooth, flat, virescent, produced on both sides in a flat point, strong, acute: tegmina virescent, immaculate; body virescent (*Fabr.*). Olivaceous flavescent turning into virescent; above with the prostethium densely and distinctly punctured; head above finely and sparingly punctured: costa sordidly flavescent: apex of the spines of the last tibiæ fuscous; head obtusely triangular, more than twice as broad as long; thorax much dilated on both sides, angles acute, the anterior margin of the dilated part about one third longer than the posterior margin, the latter infuscate; the last ventral segment in the ♀ deeply sinuated at the apex (Stål). ♀, body 18: breadth of pronotum 10 millims.

Reported from Malacca, India, Tenasserim.

## Subfamily PROCONIINA, Stål.

Ofvers. K. V.-A. Förh. p. 733 (1870).

## Genus TETTIGONIA, H. Geoffroy (in part).

Hist. Ins. p. 429 (1764) : Signoret, A. S. E. F. (2 sér.) i. p. 13 (1852).

Signoret (in *l. supra c.*) reviews the history of the group, first established by Geoffroy, in his work describing the insects found in the neighbourhood of Paris, under the name *Tettigonia*. In 1794, Fabricius separated the same group in his Ent. Syst. (iv. p. 27) under the name *Cicada*, and in his Syst. Rhyn. (1803) formed from it the genera *Jassus*, *Flata*, and *Cixius*. In 1811, Latreille re-established *Tettigonia*, and, in 1821, (Mag. Ent. iv.) Germar reduced it by creating the genera *Gypona*, *Cælidea*, and others. In 1825, Lepelletier de St. Fargeau and Audinet-Serville (Enc. Méth. x. p. 600) formed two divisions, *Tettigonia* for those in which the head is rounded beyond the eyes and *Proconia* for those in which the head is conical. In 1829, Latreille (Règne Anim. 2nd ed., ii, 221) separated *Ciccus* from *Proconia*, and, in 1832, De Laporte de Castelleau (A. S. E. F. i, p. 222) formed *Germaria* and *Rhaphidorhinus*. In 1835, Burmeister (Handb. ii, (i) p. 117) restored the *Tettigonia* of Latreille and Germar with four subdivisions, and, again in 1840, Blanchard (Hist. Nat. Ins. iii) admits divisions only. In 1843, Amyot and Serville (Hist. Nat. Ins. Hém. p. 569) admit *Tettigonia*, *Germaria*, *Ciccus*, *Rhaphidorhinus*, and *Proconia*, and add *Aulacizes*, *Diestostemma*, and *Acopsis*. In 1850, Spinola (Tav. Sin. Modena) created *Diedrocephala* and *Wolfella*, and, in the same year, Signoret created *Dilobopterus* (Rev. Zool. (2 sér.) ii, p. 284). In 1851, Fitch formed *Helochara* for an American species, and, in the same year, Walker created *Propetes*.

In 1852-54, Signoret (A. S. E. F. (3 sér.) i-iii.) keeps one genus and five groups, and notices some 396 species then recorded from all parts of the world. Stål, in 1869 (Hem. Fabr. ii, p. 59, note), includes the group in his subfamily *Jassida* and division *Proconiida*, preserving *Germaria*, *Ciccus*, *Diestostemma*, *Rhaphidorhinus*, *Proconia*, and *Tettigonia* and adding a number of his own genera. In 1870, Stål (Ofvers. K. V.-A. Förh. p. 733) raises the group to the dignity of a subfamily under the name *Proconiina*. In 1884, Taschenberg (Zeitsch. Nat. Wiss. Halle, p. 431) sinks the genera and reviews the whole as one genus with subdivisions running so closely the one into the other as not to afford good generic characters. After examining the figures given by Signoret, this appears to me to be the most reasonable solution of the difficulties connected with the arrangement of the insects belonging to this group, which now number nearly five hundred.

## 35. TETTIGONIA SEMICIRCULARIS, Signoret.

*Tettigonia semicircularis*, Signoret, A. S. E. F. (3 sér.) i, p. 348, t. 10, f. 5 (1853)  
Walker, List B. M. Suppt. p. 219 (1858).

Head rounded anteriorly, yellow, with two frontal bands united on the clypeus, white : clypeus and rostrum black : two half moons united on the vertex, a median band and on each side two spots, black : pronotum transverse with two bands, anterior one narrow and sinuated, posterior broad, uniting with the first, and on each side between them a transverse patch, black : scutellum with a semicircular band proceeding from the base, black : tegmina fuscous, with a farinose, powdery substance ; lateral margins transparent : abdomen black with the sides and border of the segments, yellow ; exterior margin pale, bordered with black, anus white : feet yellow. Long 5.6 millims.

Reported from Pondicherry.

### 36. TETTIGONIA PAVO, Signoret.

*Tettigonia pavo*, Signoret, A. S. E. F. (3 sér.) i, p. 675, t. 22, f. 4 (1853) : Walker, List B. M. Suppt. p. 218 (1858).

Bluish-black : head rounded, above bluish-black, beneath yellow with the frons and vertex between the eyes depressed : prothorax anteriorly somewhat narrow, yellow, with five spots or patches, black, of which three are on the anterior margin and two, corresponding to two on the base of the scutellum, are on the posterior margin : tegmina red, brown at the tips and exhibiting two bluish circles formed of an easily removeable farinose powder, one of these circles is on the cubital disc near the scutellary angle and the other is at the tip, half in the red part of the tegmen and half in the brown tip : wings brownish : abdomen bluish-black with the margins of the segments beneath, yellow : anal appendage as in *T. ferruginea* : feet yellow. Long 15 millims.

Reported from Bengal.

### 37. TETTIGONIA FERRUGINEA, Fabricius.

*Cicada ferruginea*, Fabricius, Ent. Syst. iv. p. 32 (1794) ; Suppt. p. 218 (1798) ; Syst. Rhynch. p. 62 (1803).

*Proconia ferruginea*, Walker, List B. M. iii, p. 783 (1851).

*Tettigonia apicalis*, Walker, List l. c. p. 736, China.

*Tettigonia confinis*, Walker, l. c. p. 736, China.

*Tettigonia addita*, Walker, l. c. p. 737, Java.

*Tettigonia gemina*, Walker, l. c. p. 737, Java.

*Tettigonia obscura*, Walker, l. c. p. 738, E. India.

*Tettigonia duplex*, Walker, l. c. p. 738, — ?

*Tettigonia reducta*, Walker, l. c. p. 739, Hong Kong.

*Tettigonia longa*, Walker, l. c. p. 740, Philippines.

*Tettigonia immaculata*, Walker, l. c. p. 740, Quito ?

*Tettigonia confinis*, Walker, l. c. p. 745, — ?

*Tettigonia ferruginea*, Germar, Mag. Ent. iv. p. 69 (1821) : Signoret, Rev. Zool. p. 176 (1853) ; A. S. E. F. (3 sér.) i, p. 676, t. 22, f. 5 (1853) : Walker, List B. M. Suppt. p. 218 (1858).



Fabricius describes this species thus :—"Head, thorax and scutellum spotted with black : tegmina red : wings white. Of median size : head glaucous, with band at the base of the rostrum, and dot on the frons and vertex, dull black : thorax sub-cinereous with an anterior spot and two posterior spots common to the scutellum, black : scutellum concolorous, with the two common spots at the base and one towards the apex, dull black : tegmina ferruginous, a little lighter at the tips : body and wings black." Signoret notes that the form of the anal appendage in the ♀ distinguishes this species. This is very large, deeply emarginate, covering a great part of the vulvar plates, more or less round on the sides and in shape like two approximated lobes. Walker describes his different species as varying from tawny to red-lead colour, testaceous, luteous or orange : the tips of the tegmina are black, lurid or brown : posterior margins of abdominal segments and tip of abdomen, red, tawny, luteous or ferruginous, so that the form of the anal appendage in the ♀ is the most steady character for distinguishing a species so variable in colour. Body long, 14-20 millims.

The Indian Museum possesses specimens from Sumatra, Tenasserim, Arakan, Sikkim, and Assam.

### 38. TETTIGONIA UNIMACULATA, Signoret.

*Tettigonia unimaculata*, Signoret, A. S. E. F. (3 sér. ii. p. 26 (1854) : Stål, Ofvers. K. V.-A. Förh. p. 734 (1870).

*Tettigonia kinbergi*, Stål, Freg. Eug. Resa, Ins. p. 288 (1859).

Whitish with yellow veins : head triangularly rounded in front with a black spot between the ocelli and on both sides, above the antennal margin, near the eyes : ocelli blackish and placed in a deep groove : basal band on thorax produced subtriangularly in the middle and two basal spots on the scutellum, black : pronotum very convex in front, straight behind above the scutellum, anteriorly transversely furrowed : tegmina fuscous or yellow-white with the streaks a little brown, costal half, whitish hyaline : abdomen and feet yellowish white ; vertex impressed on both sides. Allied to *T. albida*, Walker, from which it differs in its smaller size, narrower head, anteriorly more or less obtusely roundly-subangulated, in wanting the median black apical spot, in the thorax being more narrowed forwards, posteriorly a little broader than the head, and especially by the cavities on each side in front of the eyes in which are inserted the ocelli (*Sign.*, Stål) ♀ Body long, 5 : broad,  $1\frac{1}{2}$  millims.

Reported from Philippines, Malacca, India.

### 39. TETTIGONIA BELLA, Walker.

*Tettigonia bella*, Walker, List Hom. B. M. iii, p. 778 (1851) : Signoret, A. S. E. F. (3 sér.) ii. p. 10, t. 1, f. 8 (1854).

Black, striated and spotted yellow; head as broad as the thorax, angularly rounded in front, somewhat concave posteriorly; vertex with a stripe, a band on the posterior margin and a curved stripe on each side, frons and face with spots on each side and some larger marks in the middle, yellow; three pair of large contiguous luteous spots on the head beneath, one of these on the clypeus: thorax black, with a curved yellow band on each side: scutellum black: tegmina black, with eight yellow patches or spots; two oblique, basal; two sutural forming a patch common to the two tegmina and four marginal; of the latter those on each side nearer the base, four times longer than the others, tips lurid: abdomen black or purple, tawny at the tip beneath; legs testaceous, anterior femora marked with black: wings brown, iridescent, pale gray towards the base. In some cases the marks on the tegmina are oblong angular, more like longitudinal bands than spots (*Sign., Walk.*). Long  $5\frac{1}{2}$ -6; teg.  $12\frac{1}{3}$  millims.

Reported from N. India, Silhat.

#### 40. TETTIGONIA ASSAMENSIS, Distant.

*Tettigonia assamensis*, Distant, Ent. M. M. xvi, p. 203 (1880).

Head pale yellow, with a black fascia occupying the space between the ocelli; pronotum creamy white, the lateral margins carmine and six black spots situated transversely, two smallest near anterior margin and the four larger across the disc. Scutellum pale yellow with three black spots, two basal and one subapical: tegmina pale creamy white with a broad longitudinal subcostal carmine band, commencing near the base and extending to about the middle; a black narrow oblique band nearly crossing the tegmina at the base and at commencement of the carmine band and five dark fuscous spots situated, one in centre of carmine band, three wide apart, longitudinally on the disc, and one at the marginal apex of the coriaceous portion: wings dark fuscous with the apical borders broadly creamy white: abdomen above pitchy, underside of body pitchy; legs luteous and tarsi pitchy; face orange yellow with a large crescent-shaped black fascia about its centre and a small black spot at the base: the head is rounded in front, much broader than long, and transversely channelled on the disc (*Distant*). Body long, 13 millims.

Reported from Assam.

#### 41. TETTIGONIA EXTREMA, Walker.

*Tettigonia extrema*, Walker, List Hom. B. M. iii, p. 761 (1851): Signoret, A. S. E. F. (3 sér.) i, p. 663, t. 21, f. 4 (1853): Stål, Ofvers. K. V.-A. Förh. p. 495 (1862).

*Euacanthus extremus*, Distant, Scient. Res. 2nd Yarkand Mission, p. 15 (1879).

Pale yellow: head luteous; vertex semicircular in front, hardly concave on the posterior margin, with a slight ridge on the disc which is mostly occupied by a black mushroom-shaped patch of which the stalk rests on the posterior margin between the ocelli; face smooth, shining, with a slight ridge and on each side with indistinct oblique striæ: thorax with a median obconical patch and a rounded spot on each side, also scutellum and abdomen, brownish black: tegmina yellow with an elongated subtriangular blackish-brown stripe towards the interior margin and a similar stripe along the costa almost to the apex, gradually much amplified towards the apex and itself striped paler: wings dark brown (*Walk., Sign.*) Body long  $6\frac{1}{2}$ ; teg. long  $13\frac{1}{2}$  millims.

Reported from N. India, Murree.

#### 42. *TETTIGONIA QUADRILINEATA*, Signoret.

*Tettigonia quadrilineata*, Signoret, A. S. E. F. (3 sér.) i, p. 669, t. 21, f. 12, (1853): Walker, List Hom. B. M. Suppt. p. 218 (1858).

Head, thorax, and scutellum yellow, with two median stripes from the vertex to the posterior margin of the thorax, a fine line between these stripes on the vertex, a stripe on the lateral borders of the thorax, and three spots on the scutellum, dark brown: tegmina red with interrupted narrow longitudinal black lines, irregularly disposed in rows, tips pale. Long 12 millims.

Reported from E. India.

#### 43. *TETTIGONIA RUBROMACULATA*, Signoret.

*Tettigonia cardinalis*, Walker (*nec* Fabricius), List Hom. B. M. iii, p. 744 (1851).

*Tettigonia rubromaculata*, Signoret, A. S. E. F. (3 sér.) i, p. 668, t. 21, f. 11 (1853) Walker, List. 1. c. Suppt. p. 218 (1858).

Above deep black: head with an irregular angular black mark on the vertex, including a subquadrate black mark which proceeds from the hind border: face flat with two black stripes which unite on the clypeus, sides tawny; rostrum piceous: thorax with a transverse band and lateral bands, red: scutellum red with two triangular spots, their bases resting on the anterior margin and a sagittate mark near the apices of those spots, black: tegmina black with a number of uninterrupted longitudinal red streaks, the ends of most of which on each tegmen meet the ends of the corresponding streaks on the other tegmen: wings with a metallic tinge: tip of abdomen red; legs red, feet tawny (*Sign.*). Long with teg. 12-14 millims.

Reported from Nepál: the Indian Museum possesses specimens from Sikkim and Sibságar (Assam).



## 44. TETTIGONIA OPPONENS, Walker.

*Tettigonia opponens*, Walker, List Hom. B. M. iii, p. 757 (1851): Signoret, A. S. E. F. (3 sér.) i, p. 667, t. 21, f. 10 (1853).

Black: head and thorax slightly convex, head bright orange, concave along the posterior margin, more convex in front, with two clavate stripes and a spot between the tips of the stripes, black; beneath pale yellow, twice broader than long; face oval with a flat pale orange disc, a black stripe along two-thirds of each side is united to a black stripe on the clypeus, which is ridged and slightly compressed; rostrum pale yellow: thorax with a broad orange band which is sometimes half interrupted on the hind border and is waved along the fore border near each side of which it includes a little black cross streak, also a large subquadrate orange spot whose hind border is notched on each side near the tip of the scutellum which is tawny; legs pale yellow: tegmina dark grey with three orange stripes, costal and median united at the base, interior hardly extending beyond the middle, veins brown (*Walk., Sign.*). Long 12 millims.

Reported from N. India.

## Subfamily ACOCEPHALINA, Signoret.

*Acocephalidæ*, Fieber, Kat. p. 10 (1872): *Acocephalides*, Puton, Signoret, A. S. E. F. (5 sér.) ix, p. 47 (1879).

## 45. ACOCEPHALUS STRAMINEUS, Walker.

*Acocephalus stramineus*, Walker, List Hom. B. M. iii, p. 847 (1851); Stål, Ofvers. K. V.-A. Förh. p. 494 (1862): Signoret, A. S. E. F. (5 sér.) ix, p. 88 (1879).

*Bythoscopus stramineus*, Distant, Scient. Res. 2nd Yarkand Miss. p. 18 (1879).

*Bythoscopus indicatus*, Walker, List l. c. Suppt. p. 266 (1858).

Pale testaceous; head slightly rugose, a little narrower than the thorax, rounded and almost semicircular in front, less sinuate behind; about four times broader than long; vertex longer in the middle than on the sides; two black dots on the anterior border which forms a slight rim; face flat, broad, punctured: thorax transversely striated: scutellum very slightly punctured: tegmina almost colourless, punctured nearly to the tips, pale testaceous towards the base: wings colourless (*Walker*). Body long,  $9\frac{1}{2}$ ; teg. 21 millims.

Reported from Celebes, Java, N. China, Sind valley.

## Genus HECALUS, Stål.

A. S. E. F. (4 sér.) iv, p. 65 (1864): Hem. Afric. iv, p. 113 (1866): Signoret, A. S. E. F. (5 sér.) ix, p. 266 (1879): includes *Glossocratus*, Fieber (Rev. Mag. Zool. (3 sér.) ii, p. 403, 1875).

Body oblong or elongate, depressed : head somewhat large or somewhat so produced, apical margin acute, more or less broadly foliaceous : face dilated, somewhat deeply sinuated below the eyes ; frons a little convex : eyes small or moderate : ocelli placed on the apical margin of the head or at or near the eyes : thorax transverse, very obtusely rounded at the apex : scutellum triangular, a little broader than long : tegmina almost as long as the abdomen, margined at the apex, valvate behind the clavus, with five apical areas : feet moderate, posterior tibiæ very spinose. Allied to *Siva*, Stål, but differs in the head larger, more produced, margin foliaceous (Stål).

#### 46. *HECALUS SULCATUS*, Fieber.

*Glossocratus sulcatus*, Fieber, Verh. K. K. Zool.-bot. Gesell. Wien. xvi, p. 513, t. 7, f. 13 (1866).

*Hecalus sulcatus*, Signoret, A. S. E. F. (5 sér.) ix, p. 272, t. 8, f. 28 (1879).

Sordid yellow : vertex parallel, parabolic in front, angles very obtusely rounded : prothorax with four elongated cavities in front, finely striated transversely behind : tegmina transparent, as long as the abdomen : veins strong, yellowish, not margined ; a blackish dot at the point of the clavus : abdomen above with two bands of small brown patches, two at the base of each segment : feet entirely sordid yellow, unicolorous : ventral segments parallel, median lobe obtusely salient, sides sinuated (Fieber). ♀, body long, 11 millims.

Reported from E. India. Signoret considers this species to be probably one with *H. parva*, Walker (List iii, p. 828), though he gives the latter also with a ? as a synonym possibly of *H. paykulli*, Stål, who, however, makes it a *Selenocephalus* in Ofvers. K. V.-A. Förh. p. 494 (1862).

#### 47. *HECALUS PAYKULLI*, Stål.

*Petaloccephala paykulli*, Stål, Ofvers. K. V.-A. Förh. p. 252 (1854).

*Hecalus paykulli*, Stål, A. S. E. F. (4 sér.), iv, p. 64 (1864) : Signoret, *ibid.* (5 sér.) ix, p. 270 (1879), t. 7, f. 26.

Sordid whitish-yellow, smooth, shining, clouded with brown on the vertex, the length of the median line, and transversely on the prothorax, the tegmina and the veins of the same colour but with a brown line on each side. Head defined on the margin only, one and half times longer than the prothorax, as long as broad between the eyes, angularly rounded, the sides almost parallel above the eyes, then forming an angle at the tip ; two excavations on the vertex on each side. Frons convex with a foliaceous border anteriorly, grooved on the sides, border concave above the clypeus which is itself broader at the base than at the tips but showing its greatest breadth in the middle, carinate in its median part. Rostrum very short. Genæ with the tip oblique from the

clypeus to the eye forming a very acute angle, concave, sinuous towards the clypeus then emarginate, concave near the eye. The prothorax a little more than twice broader than long, finely striated transversely in the posterior half and with several less marked impressions anteriorly. Tegmina opaque with four discoidal areas of which two are anteapical, five apical areas and three in the marginal space; a black dot occurs at the tip of the claval angle. Wings hyaline with the third sector re-united at the internal branch of the bifurcation of the second sector, then bifurcate and forming a long angular cell. Pectus and abdomen yellow: the latter a little deeper towards the base of the dorsal segments. ♂ has last segment of the abdomen hardly longer than the preceding, apical margin straight; a very small genital appendage; genital plates very narrow at the tip almost as long as the hypopygium and pubescent on the sides; the hypopygium a little broader and pubescent, the anal tube is surrounded by it and extends beyond it by very little. The ♀ has the last segment twice as long as the preceding, convex at the superior margin, angular in the middle and weakly sinuated on each side; the genital appendages or valvules are more than twice as long as the preceding and the oviduct extends beyond them by about one-third (*Signoret*). Stål writes:—Shining, sordid whitish-yellow; head (eyes excepted) almost equally long and broad, longer by half than the thorax, anteriorly slightly narrowed, smoothish: tegmina opaque; eyes fuscous. ♂ Body long 5; broad, hardly 2 millims: ♀, body long 6; broad, 2 millims: Stål gives ♀ long  $8\frac{1}{2}$ ; breadth thorax 2 millims.

Reported from China, Senegal, (Australia?), Silhat.

#### Genus THOMSONIELLA, Signoret.

A. S. E. F. (5 sér.) x, p. 52 (1880).

Separated from *Hecalus*, Stål, by the presence of six discoidal areolas. Body depressed: head prolonged in front, foliaceous on the anterior margin of the vertex, with a groove throughout its entire length, vertex depressed, also the frons, the latter with the grooves and lateral sutures extending to the anterior border of the head: genæ sinuated, rounded in the middle: the lores occupying the entire space between the margin of the genæ and the frontal suture: sides of clypeus almost parallel, rounded at the tip, one and half times longer than broad: prothorax transverse, almost broader than the head with the eyes: tegmina transparent hyaline with a narrow marginal limbus: rest as in *Hecalus* (*Signoret*).

#### 48. THOMSONIELLA KIRSCHBAUMII, Stål.

*Hecalus kirschbaumii*, Stål, Ofvers. K. V.-A. Förh. p. 737 (1870).

*Thomsoniella kirschbaumii*, Signoret, A. S. E. F. (5 sér.) x, p. 52, t. 1, f. 44 (1880).



Pale yellow, shining, with a dot at the tip of the clavus and on the middle of the first apical area, black : anterior margin of vertex blackish. Head a little shorter than broad between the eyes, the anterior margin weakly angularly rounded and reflexed, vertex concave, ocelli in the groove very close to the eyes. Frons convex, almost as long as broad, the sides much rounded : genæ broad with the angle very obtusely rounded. Prothorax convex anteriorly, concave behind, the lateral margins very slightly convex, almost parallel ; finely, transversely striated. Clypeus with the sides parallel, rounded at the tip. Tegmina rounded at the tips with four broad apical and six discoidal cells, the sixth comprising a small hexagonal cellule with equal sides before the third apical cell ; there is also a supplementary cellule ; limbus very narrow, a transverse vein between the two veins of the clavus. Abdomen long, the last segment (♀) twice as long as the penultimate with the margin sinuous, emarginate in the middle and furnished with a rounded median lobe ; valvules one half longer and the oviduct extending beyond them by a third. ♀, body long, 6 ; broad, 2 millims.

Reported from Philippines, Ceylon, India.

Resembles *P. wallengrenii*, Stål, but differs in the more rounded head, in the number of discoidal cellules, and in the groove on the border of the head (*Sign.*).

#### Genus SELENOCEPHALUS, Germar.

Silbermann's Rev. Ent. i, p. 180 (1833) : Burmeister, Handb. ii, (i), p. 111 (1835) : Amyot and Serville, Hist. Nat. Ins. Hém. p. 583 (1843) : Stål, Hem. Afric. iv, p. 108 (1866) : Fieber, Rev. Mag. Zool. (3 sér.) iii, p. 399 (1875).

Body oblong : head short, broadly rounded at the apex, apical margin with a furrow : vertex flat, horizontal : face dilated, depressed at the base, lateral margins slightly sinuated beneath the eyes : ocelli placed in the furrow of the apical margin of the head at or near the eyes : thorax transverse, rounded anteriorly : scutellum a little broader than long, triangular : tegmina extending beyond the apex of the abdomen, membranous, margined at the apex, valvate behind the clavus, with 4-5 apical areas : feet moderate, posterior tibiæ, a little compressed, very spinose (Stål).

#### 49. SELENOCEPHALUS EGREGIUS, Stål.

*Selenocephalus egregius*, Stål, A. S. E. F. (4 sér.) iv, p. 66 (1864) : Signoret, ibid. (5 sér.) x, p. 62, t. 2, f. 52 (1880).

Light olive green, smooth ; vermilion spots on the head, prothorax and scutellum, glossy. Head very little broader than the prothorax, rounded in front ; vertex not longer in the middle than towards the

eyes, with a biarcuated band of vermillion, margin with a slight groove, ocelli a little distant from the eyes; frons with the sutures concave, then convex at the tip, weakly impressed in front. Clypeus one and half times longer than broad, spatuliform; lores much rounded; genæ broad, tip convex, a little sinuate in front of the subocular piece. Prothorax two and half time broader than long, thrice longer than the vertex and with a vermillion band in front which starting from the middle of the anterior margin proceeds obliquely towards the middle of the lateral borders where it ends in a round spot. Scutellum broader than long with four round dots at the base, two lateral towards the transverse stria and the tip, vermillion. Tegmina hyaline golden-yellow with the side strong and vermillion up to beyond the middle, veins blackish, the transverse blacker and with two lateral spots along the border, three at the suture and the extremity, black. Wings slightly infusate with a lighter space in the supplementary cellule: body and feet yellow olive with deeper shades at the base of the abdominal segments: last ventral segment in ♀ scarcely longer than the preceding, emarginate in the middle with a median lobe, the sides very oblique, trilobate: valvules thick, round, pubescent at the extremity; hairs yellow at the base, black at the tip: oviduct blackish just extending beyond the valvules (*Sign.*). ♀, body long, 8 millims.

Reported from Burma.

#### 50. SELENOCEPHALUS CULTRATUS, Walker.

*Ledra culobata*, Walker, List Hom. B. M. iii, p. 827 (1851).

*Ledra cultrata*, Walker, l. c. iv, p. 1159 (1851).

*Selenocephalus cultratus*, Stål, Ofvers. K. V.-A. Förh. p. 494 (1862).

Testaceous, almost fusiform; head conical, as broad as the thorax, shagreened, very slightly arched, very slightly concave along the hind border, with a very indistinct middle ridge, on each side of which there is a very slight furrow; its length a little less than its breadth; sides slightly angular; fore-part of the underside with slight diverging ridges which are at right angles to the slight oblique ridges on each side of the face; a piceous spot in front of each eye: ocelli near the hind border: thorax very slightly convex, hardly striated transversely, indistinctly impressed on each side; scutellum with a slight arched transverse suture near the tip: abdomen as broad as the thorax with seven slight black stripes: legs marked with black: tegmina pale testaceous, not punctured: wings colourless (*Walker*). Body long 10; teg.  $14\frac{1}{2}$  millims.

Reported from India.

#### Genus PETALOCEPHALA, Stål.

Stål, Ofvers. K. V.-A. Förh. p. 266 (1856); Hem. Afric. iv, p. 103 (1866).

Body very oblong or a little clongate, depressed : head clypeated, foliaceous, produced anteriorly ; vertex somewhat flattish ; face beneath the eyes abruptly very much narrowed, thence gradually, margins very slightly defined ; frons small, narrow, flattish : eyes small : ocelli situate towards the base of the vertex, more distant from the eyes than from each other : thorax transverse, sexangular, not or only very slightly narrowed forwards, lateral margins acute, anterior-lateral much longer than posterior-lateral, anterior margin slightly rounded : scutellum triangular, subequilateral : tegmina subcoriaceous, pellucid, densely punctured, tectiform anteriorly conjointly convex, clavus very broad before the middle, corium obliquely rounded at the apex, veins irregularly anastomosed towards the apex, less distinct : feet somewhat short ; first coxæ free ; last tibiæ above remotely dentated. Type *Petalocephala bohemani* (Stål).

#### 51. PETALOCEPHALA CHLOROCEPHALA, Walker.

*Ledra chlorocephalus*, Walker, List Hom. B. M. iii, p. 825 (1851).

*Petalocephala chlorocephala*, Stål, Ofvers. K. V.-A. Förh. p. 494 (1862).

Testaceous, paler beneath, almost fusiform ; head and thorax thickly punctured ; head flat, conical, as broad as the thorax, very slightly arched, very slightly concave along the hind border, green in front with a median ridge ; its length a little more than half its breadth ; three ridges beneath, the middle one tapering to the fore border, the side pair curved outward : thorax almost flat, shield tinged with green on each side of the hind border : legs pale testaceous : tegmina almost colourless, testaceous towards the base, brown at the tips, with a small black spot in each disc : wings colourless (*Walker*). ♂, body long, 10 ; teg. 20 mils.

Reported from N. India.

Genus SIVA, Spinola.

Gen. Ins. Artr., p. 167 (1852) : Stål, Hem. Afric. iv, p. 112 (1866) : Signoret, A. S. E. F. (5 sér.) x, p. 197 (1880).

Body very oblong, somewhat depressed, above slightly convex : head narrower than the thorax, short, rounded anteriorly or obtusely rounded subangularly, anterior margin somewhat acute but not foliaceous : vertex horizontal, flat, about twice broader than the eyes ; face dilated, frons and clypeus somewhat flat ; frons longer than broad ; clypeus spatuliform ; genæ broad with the angle more or less angular and more or less emarginate : ocelli placed at the eyes on the anterior margin of the head : thorax transverse, narrowed forwards, twice broader than long, slightly rounded at the apex, almost straight above



the scutellum, lateral margins acute: scutellum triangular, a little broader than long: tegmina barely extending beyond the tip of the abdomen, tip narrow, irregularly veined: feet moderate, last femora compressed, last tibiæ very spinose. Allied to *Selenocephalus*.

## 52. *SIVA STRIGICOLLIS*, Spinola.

*Siva strigicollis*, Spinola, Tav. Sinot. p. 127 (1852): Signoret, A. S. E. F. (5 sér.) x, p. 198, t. 6, f. 64 (1880).

*Selenocephalus costalis*, Stål, Freg. Eug. Resa, Ins. p. 290 (1859): A. S. E. F. (4 sér.) iv, p. 66 (1864) ♀.

*Siva costalis*, Stål, Ofvers. K. V.-A. Förh. p. 736 (1870) ♀.

Very pale yellow with two black spots on the tip of the vertex and one at the tip of each clavus: head and pronotum striated transversely. Head narrower than the pronotum, round in front, thickened and reflexed, with two small black median spots, a median line and slight transverse striæ; breadth between the eyes a little smaller than the eyes together: face transversely striated, stronger and more oblique on the sides: frons longer than broad, flat at the base, more convex at the tip, the grooves and base of a brighter citron yellow: genæ with parallel circular streaks on the upper border which is circular, slightly sinuate beneath the eyes, the portion below the eyes and antennæ, glossy: clypeus twice longer than broad, broadly spatuliform at the tip, transversely striated and a little carinate at the base: lores longer than broad. Pronotum twice broader than long, grooved strongly and almost parallel, anterior border slightly convex, sides oblique and posterior border almost straight, angles oblique: scutellum broader than long with three spaces bounded by the angles, those at the base almost glossy, that at the tip, strongly transversely striated. Tegmina rugose, punctured, longer than the abdomen, veins strong: wings large, milky. Pectus yellow with paler spaces; feet yellow, femora flat, posterior tibiæ very spiny: abdomen uniform yellow.

♂ last ventral segment much larger than the penultimate but less broad, pubescent, almost square with the apical margin almost straight a little sinuate in the middle, angles round; covering almost entirely the plates of the genitalia and of half the hypopygium; the former very narrow, slightly pubescent; the latter forming two valves irregularly rounded at the tip and armed on the disc and sides with a few spiny hairs.

♀ last ventral segment a little longer on the sides than the penultimate not longer in the middle, lateral angles, acute, round at the tip, the middle concave, without sinuosities: the valvules four times longer, hardly pubescent, extending a little beyond the oviduct which is short

and enclosed by the dorsal tip of the valvules, the anal tip visible from below, invisible from above (*Sign.*). Body long, 10-11 millims.

Reported from Philippines, Coromandel, India.

### Genus DRABESCUS, Stål.

Subgenus, Ofvers. Kong. Vet. Aka. Förh. p. 738 (1870): *Dabrescus*, Signoret, A. S. E. F. (5 sér.) x, p. 207 (1880).

Ocelli remote from the eyes, almost more distant than the antennæ: anterior tibiæ above broadly subsulcate, superior margin of the first tibiæ distinctly dilated: formed from *Selenocephalus*.

### 53. DRABESCUS NERVOSOPUNCTATUS, Signoret.

*Dabrescus nervosopunctatus*, Signoret, A. S. E. F. (5 sér.) x, p. 209, t. 7, f. 72 (1880).

Yellow, spotted with brown: vertex very short, at least four times broader than long between the eyes, a little longer towards the eyes than in the middle; in front a blackish patch and in the middle, a black median line: ocelli as distant from the eyes as from the median line: frons black, very finely rugose, almost as long as broad at the base which is yellowish, but bounded on the margin itself of the head by a blacker line which is continued on the eyes in a lighter shade. Scrobe oblique reaching the vertex at the level of the eyes. Clypeus black, carinate, spatuliform, rugose and with two small excavations at the tip: Genæ yellow with a blackish spot beneath the antennæ which is punctured with yellow dots; almost as broad as long, with the border free, straight from the clypeus to the external angle of the eye with a weak sinuosity above the anterior coxæ and a stronger beneath the eyes. Antennæ very short, yellow, the base of the second joint and the third joint black. Pronotum nearly thrice broader than long, yellow-brown, with brown spots furnished with light yellow round dots; finely striated transversely in all its length. Scutellum brown, with irregular, long or round dots, yellow. Tegmina golden-yellow hyaline, in appearance rugose, and furnished with brown veins, almost black with white dots regularly placed, the side brown, punctured white; in addition a band at the basal third and almost the upper half, brown, lighter in the middle but forming deep spots on the side in a line with the transverse discoidal vein on the suture at the level of the tip of the clavus, in a line with the transverse veins of the apical cellules; extremity of the apical cellules and the limbus, blackish. Wings hyaline, infusate at the tip: pectus and feet yellowish brown; base of the spines of the posterior tibiæ and the tip of the claws, blackish: abdomen yellow, with the median part of the

dorsum broadly, a narrow median band on the venter, the tip of the last segment and the oviduct, black. ♀ with last segment twice as long as the preceding, weakly sinuate at the tip with a very small extension in the middle (*Sign.*). ♂, body long, 10; broad,  $3\frac{1}{2}$  millims.

Reported from N. India.

#### 54. DRABESCUS ANGULATUS, Signoret.

*Dabrescus angulatus*, Signoret, A. S. E. F. (5 sér.) x. p. 210, t. 7, f. 73 (1880).

In appearance very like *D. nervoso-punctatus*, Sign., from which it differs by the vertex being angular in the middle, frons longer, tegmina rugose although hyaline, the rugosities very close to each other, yellow, whitish at the tip and streaked with black in the hollows which they form, veins brown alternated with white dots, clavus with two transverse veinlets, one between the two veins and the other between the anal vein and the claval suture. Tegmina with a white, rugose, hyaline, basal band; a broad band, streaked black; a white hyaline band; a broad band streaked with black on the anteapical areas; further the length of the apical cellules, of a golden hyaline, yellow, glossy not rugose, the marginal border deeper infusate with a brown spot at the tip of the fourth external apical area.

Vertex very short angularly rounded in front, a little longer in the middle than towards the eyes, concave in the latter direction, convex in the middle, the extreme edge forming a light yellow ridge bounded on the vertex by a black line, on the frons by a black band confluent with the frons itself which is black, yellowish brown at the tip and along the sides; longitudinally striated and without lateral grooves. The remainder as in *D. nervosopunctatus*, except that the ♀ has the last ventral segment strongly emarginate in the middle, sinuated on the sides, the angles angularly rounded, and at this point twice as long as the preceding segment, although in the middle it is hardly as long. Oviduct and genital plates yellow, the latter a little shorter of the two (*Sign.*). Body long, 9; broad 3 millims.

Reported from N. India.

#### Subfamily JASSINA, Stål.

Ofvers. K. V.-A. Förh. (pt.) p. 735 (1870).

#### Genus JASSUS, Fabricius.

Syst. Rhyng. p. 85 (1803): Stål, Hem. Afric. iv. p. 119 (1866): Spångberg, Ofvers. K. V.-A. Förh. no 8 p. 3 (1878): *Cælidia*, Germar, Burmeister.

Body oblong, subcylindrical; head a little narrower than the thorax, obtuse or very obtuse on the anterior margin; vertex horizontal, a little



narrower than the eyes, gradually somewhat amplified forwards; face dilated, more or less reclined, frons occupying the greatest part of the intraocular breadth of the face, very slightly convex; clypeus produced and amplified at the apex, truncated: ocelli situate on the apical margin of the head near the eyes: thorax transverse, short, shorter than the scutellum: scutellum hardly shorter than long, subequilateral, large: tegmina margined at the apex, valvate behind the clavus, with five apical areas: feet somewhat long; posterior tibiæ very spinose (Stål).

#### 55. JASSUS DEPLANATUS, Spångberg.

*Jassus deplanatus*, Spångberg, Ofvers. K. V.-A. Förh. no 8, p. 23 (1879).

? *Calidia indica*, Walker, List Hom. B. M. iii. p. 855 (1851).

? *Tettigonia jactans*, Walker, l. c. Suppt. p. 357 (1858).

Sordid yellowish white; vertex, face and feet weakly subferruginous yellowish, sides of frons weakly cinnabar: pronotum and scutellum black-fuscous, the former with sordidly flavescent-white granules; pectus and abdomen black, the former more or less spotted with flavescent, segments of the latter, posteriorly, narrowly margined with sordid yellow; tegmina sordidly flavescent white, densely spotted with fuscous; costal spot a little beyond the middle subtriangular, large, sordidly whitish hyaline and a fuscous spot placed behind the preceding, both fuscous at the apex, veins more obscure, fuscous, sordidly spotted with white: wings fuscous. The last segment of the abdomen in the ♀ almost twice as long as the penultimate, slightly sinuated on both sides at the apex, median lobe somewhat produced, rounded posteriorly (*Spångberg*). ♀, body long, 8; broad,  $2\frac{1}{2}$ : body and tegmina long, 9 millims.

Reported from E. India.

#### Genus THAMNOTETTIX, Zetterstedt.

Ins. Lapp. p. 292 (1840): Stål, Hem. Afric. p. 101, 122 (1866): Scott, E. M. M. xii. p. 21 (1875).

Body oval or very oblong: head variable in breadth and shape, obtuse or very obtuse on the anterior margin: vertex horizontal: face dilated, reclined, slightly convex; frons occupying the greatest part of the intraocular breadth of the face: ocelli placed on the anterior margin of the head at or near the eyes: thorax transverse: scutellum moderate or small, equal in length to the thorax or shorter: tegmina membranous with 4-5 apical areas, most often valvate and margined at the apex: feet moderate, posterior tibiæ, very spinose (Stål).

#### 56. THAMNOTETTIX BIPUNCTATA, Fabricius.

*Cicada 2-punctata*, Fabricius, Syst. Rhynch. p. 78 (1803).

*Thamnotettix bipunctata*, Stål, Hem. Fabr. ii. p. 82 (1869).

Yellowish green, shining, smooth : frons (except the lateral margins) entire lores or beneath the middle, a spot before the middle and the apical two-fifths of corium and lateral spots on the pectus and abdomen, black, the incisures of the abdomen greenish-yellow : wings infusate. ♂, body long  $4\frac{2}{3}$  ; broad,  $1\frac{1}{6}$  millims.

Reported from Tranquebar. Head scarcely as broad as the thorax and a little shorter very obtusely roundly subangulate : vertex about twice as broad as the eyes, hardly twice as broad as long, slightly impressed within the anterior margin ; face very slightly convex : thorax hardly more than two and half times broader than long, obtusely rounded anteriorly : tegmina rounded at the apex, valvate behind the clavus (Stål).

#### Genus HYLICA, Stål.

Stål, Trans. Ent. Soc. Lond. (3 sér.) i. p. 593 (1863).

Body oblong-obovate : head acutely produced, face somewhat reclined : ocelli placed on the upper part of the head, near the anterior angles of the eyes : rostrum very short : thorax somewhat elevated backwards, tuberculated, anterior lateral margins long, anterior middle angularly produced : scutellum elevated, tuberculated : tegmina subcoriaceous, broadly membranously margined at the apex : abdomen broader than the tegmina, posterior segments acutely lobed and reflexed on both sides : feet somewhat short, anterior tibiae above somewhat dilated, posterior above spinose. Close to *Tettigonia* (Stål).

#### 57. HYLICA PARADOXA, Stål.

*Hylica paradoxa*, Stål, Trans. Ent. Soc. Lon. (3 ser.) i. p. 593 (1863).

Body oblong-obovate, blackish or fuscous-testaceous ; face below the middle (a black spot excepted), disc or two broad stripes on the venter sordidly stramineous. Var. *a*, feet sordidly stramineous, annulated with fuscous. Var. *b*, feet fuscous-testaceous ; femora palely banded. ♀, body long, 10 : broad,  $3\frac{1}{2}$  millims.

Frons produced at the base in a short, compressed, slightly curved horn and furnished in the middle with two small tubercles : two posterior, distant tubercles on the thorax, higher than the rest, compressed : scutellum much elevated before the middle, furnished near the apex with a conical tubercle ; disc of the elevated part hollowed out and more compressly-elevated on both sides (Stål).

Reported from Burma.

#### Genus PENTHIMIA, Germar.

Mag. Ent. iv. p. 46 (1821). Stål, Hem. Afric. iv. p. 100. 107 (1866) : Fieber. Rev. Mag. Zool. (3 sér.) ii. p. 392 (1875).

Body oval or ovate, somewhat depressed: head obtuse, anteriorly rounded; vertex somewhat sloped, slightly convex before the middle; lateral margins of face, somewhat distinct; frons a little convex; clypeus flat or very slightly convex: eyes moderate: ocelli placed on the disc of the vertex, more distant from each other than from the eyes: thorax transverse, a little narrowed forwards, anterior margin round: tegmina margined at the apex, valvate behind the clavus, 4-5 apical areas: feet moderate; femora compressed; last tibiæ very spinose (Stål).

#### 58. PENTHIMIA ORIENTALIS, Walker.

*Penthimia orientalis*, Walker, List Hom. B. M. iii. p. 841 (1851).

Deep black, oval: head and chest convex, thinly punctured: posterior border of pectns, red: tegmina thickly punctured; tips of tegmina and wings brown. Body long, 7: teg.  $14\frac{1}{2}$  millims. A variety has the abdomen red on each side towards the tip: anterior tibiæ and feet mostly red (Walker).

Reported from N. India.

#### 59. PENTHIMIA COMPACTA, Walker.

*Penthimia compacta*, Walker, List Hom. B. M. iii. p. 842 (1851).

Ferruginous, short, broad: head and anterior margin of thorax, black: head very short, nearly as broad as the thorax, slightly concave posteriorly, rather more convex in front; face convex, distinctly transversely sulcated; thorax convex, minutely punctured black towards the fore border: tegmina piceous, ferruginous along the posterior margin: wings almost colourless (Walker). Body long, 3: wings long,  $6\frac{1}{4}$  millims.

Reported from N. India.

#### 60. PENTHIMIA CASTANEA, Walker.

*Penthimia castanea*, Walker, J. L. S. Zool. i. p. 98 (1856).

Ferruginous, smooth, shining: head black in front and beneath: pectus black in front and with a black spot on each side behind: legs black; tibiæ very spinose: tegmina lurid and with black spots towards the tips (Walker). Body long, 5; teg.  $10\frac{1}{2}$  millims.

Reported from Malacca, Tenasserim.

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### ADDITIONS AND CORRECTIONS.

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#### 61. MONECPHORA TRIMACULA, Walker.

*Monecphora trimacula*, Walker, List Hom. B. M. iii. p. 682 (1851).

Body long,  $7\frac{1}{4}$ : exp. teg.  $18\frac{3}{4}$  millims: reported from India.



## 62. SPHENORHINA CONTIGUA, Walker.

*Sphenorhina contigua*, Walker, l. c. p. 695 (1851).

Body long,  $8\frac{1}{2}$ ; teg.  $18\frac{3}{4}$  millims: reported from N. India.

## 63. SPHENORHINA INTERMEDIA, Walker.

*Sphenorhina intermedia*, Walker, List l. c. p. 695 (1851).

Body long,  $7\frac{1}{4}$ ; teg.  $16\frac{3}{4}$  millims: reported from N. India.

## 64. SPHENORHINA PROXIMA, Walker.

*Sphenorhina proxima*, Walker, List l. c. p. 695 (1851).

Body long,  $7\frac{1}{4}$ ; teg.  $14\frac{1}{2}$  millims: reported from N. India.

## 65. SPHENORHINA BRACONOIDES, Walker.

*Sphenorhina braconoides*, Walker, l. c. Suppt. p. 185 (1858).

Body long,  $6\frac{1}{2}$ ; teg.  $16\frac{3}{4}$  millims: reported from Burma.

## 66. SPHENORHINA APPROXIMANS, Walker.

*Sphenorhina approximans*, Walker, l. c. Suppt. p. 185 (1858).

Body long,  $6\frac{1}{2}$ - $8\frac{1}{2}$ ; teg.  $16\frac{3}{4}$ -19 millims: reported from N. India.

## 67. POOPHILUS COSTALIS, Walker.

*Ptyelus costalis*, Walker, List Hom. B. M. iii. p. 707 (1851): Stål, Ofvers. K. V.-A. Förh. p. 493 (1862).

*Ptyelus concolor*, Walker, List l. c. p. 715 (1851).

*Ptyelus dolosus*, Walker, List l. c. Suppt. p. 189 (1858).

*Ptyelus rotundatus*, Signoret, in Thoms. Arch. Ent. ii. p. 332 (1858).

*Ptyelus natalensis*, Stål, Ofvers. K. V.-A. Förh. p. 97 (1858).

*Poophilus natalensis*, Stål, Hem. Afric. iv. p. 74 (1866).

More or less weakly or obscurely ivory-grey, pubescent; tegmina varied with fuscous; frontal part of anterior margin of the head, pallid, with five black spots: wings colourless, slightly infusate at the apex: ventral disc black: tegmina nearly thrice longer than broad, apical half narrowed: frons and anterior feet, fuscous; apex of femora pallid (*P. natalensis*, Stål). ♀, long 9-10; broad,  $3\text{--}3\frac{1}{2}$  millims.

Reported from S. and W. Africa, Ceylon, N. India. Stål notes that his Ceylon example differs from the S. African in the head being a little more obtuse and more rounded.

## 68. CLOVIA CONIFER, Walker.

*Ptyelus conifer*, Walker, List Hom. B. M. iii. p. 711 (1851); J. A. S. B. liv. (2), p. 19 no. 38 (1885).

*Ptyelus simulans*, Walker List l. c. p. 717 (1851).

*Ptyelus frenulatus*, Stål, Ofvers. K. V.-A. Förh. p. 250 (1854): l. c. p. 493 (1862).

Head and thorax ferruginous, flat, very thickly and minutely punctured, covered with tawny down: head short, indistinctly striped with brown, sinuate along the hind border, more rounded in front, its length not more than one-fourth of its breadth; face piceous, roughly punctured, with ten slight oblique ridges on each side of the disc which is flat; two yellow stripes along the sides unite near the front and form a cone and are produced along the pectus: the clypeus shining, convex, ferruginous, with an oblique furrow on each side; rostrum ferruginous, tip piceous; pectus with a broad black band between the anterior and intermediate legs: abdomen ferruginous, testaceous at the base: legs testaceous: tegmina ferruginous, conical towards the tips which are almost pointed, nearly colourless for half the breadth beneath the fore-border from the middle to the tips; some forked brown streaks in the disc, a few of them communicating with an irregular curved brown stripe which extends from three-fifths of the length of the fore-border to the tip and is darkest at each end: wings colourless; veins black, tawny at the base (*Walker*). Body long,  $6\frac{1}{4}$ ; teg.  $16\frac{1}{2}$  millims.

Reported from India, Java.

#### 69. CLOVIA PUNCTUM, Walker.

*Ptyelus punctum*, Walker, List Hom. B. M. iii. p. 718 (1851); Stål. Ofvers. K. V.-A. Förh. p. 493 (1862); J. A. S. B. liv. (2), p. 19 (1885).

*Ptyelus bipunctipennis*, Stål, l. c. p. 250 (1854): Java.

Pale tawny, covered with pale down: head and thorax almost flat: head very convex in front, with two furrows which diverge from the fore border and communicate with two more oblique impressions near the hind border; face very convex, with a blackish disc, which has about eight oblique ridges on each side; disc of the breast, blackish: tegmina with a dark brown dot on the hind border near the tip; wings colourless; veins pale stramineous (*Walker*). Body long, 5: teg.  $11\frac{1}{2}$  millims.

Reported from N. Bengal, Java.

#### 70. PTYELUS SEXVITTATUS, Walker.

*Ptyelus sexvittatus*, Walker, List Hom. B. M. iii. p. 715 (1851); J. A. S. B. liv. (2), p. 19 (1885).

Yellow, shining: head and chest flat, minutely punctured, adorned with six black stripes: head concave along the hind border, almost conical in front; its length less than half its breadth; face very convex with indistinct ridges on each side, black towards the clypeus which is also black: disc of the pectus mostly black: abdomen piceous: a short dorsal stripe, hind borders of the segments, and oviduct, tawny: legs

yellow ; tips of the hind tibiæ and of the hind feet, piceous : tegmina brown, narrow, with two very large white spots on the fore border, with two indistinct whitish marks near the base, and with two more along the hind border : wings colourless ; veins tawny, pale yellow towards the base (*Walker*). Body long, 5 ; teg.  $12\frac{1}{2}$  millims.

Reported from N. India.

#### 71. PTYELUS SUBFASCIATUS, Walker.

*Ptyelus subfasciatus*, Walker, List Hom. B. M. iii. p. 724 (1851) ; J. A. S. Ben. liv. (2), p. 19 (1885).

Pale tawny, shining, very finely punctured : head above luteous, slightly concave along the hind border, very convex in front ; face very convex, piceous towards the clypeus which is also piceous ; ridges on each side very slight : thorax with six brown stripes ; a brown spot on each side by the base of the tegmina : disc of the pectus, black : abdomen piceous, pale tawny at the base : tips of the hind tibiæ, black : tegmina brown with a tawny spot on each side at the base and with two white bands, the first not reaching the hind border, the second interrupted in the middle : wings colourless, veins tawny (*Walker*). Body long,  $3\frac{1}{2}$  ; teg.  $8\frac{1}{2}$  millims.

Reported from N. India.

#### 72. UROPHORA HARDWICKII, Gray.

*Urophora hardwickii*, Gray, Griffith's ed. Animal kingdom, Ins. ii. p. 261, t. 90, f. 3 ; t. 138, f. 5 a-d. (1832) : Walker, List Hom. B. M. iii. p. 645 (1851).

The characters of the genus and species are given thus by Gray :—"the thorax produced over the head ; the posterior legs simple and with the ovipositor forming a long tube ; fulvous with the tegmina spotted between the veins with brown ; the legs and ovipositor obscure" : near *Æthalion*, Latr. Body long, 18 ; ovipositor long, 13 millims.

Reported from Nepal : the Indian Museum possesses specimens from Sikkim, Assam.

Journal, liii. (2) No. 3 for 1884, p. 219 No. 26, *H. transversa*, Walker is the same as *Gæana dives*, West l. c. p. 221, No. 34.

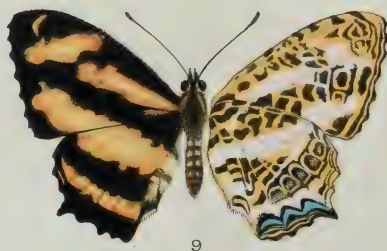
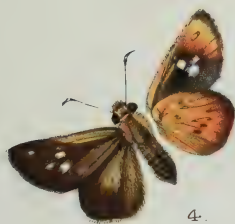
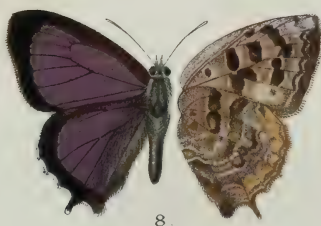
l. c. p. 224, *D. lateralis*, Walker, No. 41 is the same as *D. vibrans*, Walker, No. 43.

l. c. p. 225, *D. immacula*, Walker, No. 52 is the same as *D. mannifera*, Linn, No. 39.

l. c. p. 229, omit *C. subtineta*, Walker, No. 70 : Walker's locality is incorrect.

l. c. p. 229. *C. ancea*, Walker, No. 71 is included in *C. striata*, Walker, List i. p. 206.







l. c. p. 230. *Cicada subvitta*, Walker, No. 73 is a TIBICEN.

l. c. p. 230. *Cicada xantes*, Walker, No. 75 is a CICADATRA.

l. c. p. 231, *Fidicina operculata*, No. 81 is the same as *Fidicina Bubo*, Walker, List, p. 82 and is a CRYPTOTYMPANA.

l. c. p. 231. *Fidicina corvus*, Walker, No. 82 is a CRYPTOTYMPANA.

l. c. p. 232. *T. apicalis*, Germar, No. 14 includes also *Cicada semicincta*, Walker, List, i. p. 142.

l. c. p. 232. *M. illustrata*, Am. & Serv. No. 85 and *M. recta*, Walker, No. 86 are the same as *M. conica*, Germar.

l. c. 233. *M. quadrimacula*, Walker, No. 93 is a CICADATRA.

l. c. p. 233. *M. tersichore*, Walker, No. 94 is a DUNDUBIA.

Journal liv. (2) No. 1 for 1885, p. 19. *P. quadridens*, Walker, No. 39 includes as a variety *Clovioa guttifer*, Walker, l. c. p. 20, No. 44 and is a CLOVIA.

# X.—*Descriptions of some new Indian Rhopalocera.*

By LIONEL DE NICEVILLE.

[Received, Feby. 7th,—Read, March 4th, 1885.]

(With Plate II.)

. SYMBRENTHIA SILANA, n. sp., Pl. II, Fig. 9, ♂.

♂. UPSIDE black, *forewing* with a very regular streak from the base to beyond the cell extending slightly below the median but not touching the subcostal nervure, a subapical irregular streak not quite reaching to the costa or the outer margin, beyond which is a curved narrow lunular line; a broad band placed obliquely from the second median nervule to the inner margin. *Hindwing* with a broad discal band, a submarginal one less than half the width of the discal band becoming attenuated anteriorly, an obsolete (hardly traceable) very fine marginal line; all these markings bright ochreous paler in the middle. UNDERSIDE with the markings as above but glossy opaline white, the black ground-colour replaced by prominent black and yellow tessellations. *Hindwing* with a discal series of five imperfect somewhat cone-shaped ocelli of moderate size, the three nearest the anal angle centred with brilliant metallic blue; three lunules of that colour at the anal angle. *Both wings* with the margin black, a submarginal fine line defined with yellow on both sides.

♀. Larger, the *forewing* broader, the outer margin evenly curved. Markings throughout paler, except the blue ones on the underside of the



hindwing, which are larger and more prominent. The subapical streak on the upperside of the forewing touching the costa, and a small narrow spot just within it.

*Expanse* ♂ 2.1, ♀ 2.3.

HAB. Buxa, Bhutan (*Moti Ram*), Sikkim (*Otto Möller*).

Near to *S. niphanda*, Moore, which also occurs in Sikkim, but may be at once distinguished from that species by the ochreous bands on the upperside being much wider, and on the underside much paler also. The five cone-shaped imperfect ocelli are less than half the size of those of *S. niphanda*, and the centres of three of them and the anal lunules are pure cerulean blue instead of green.

NACADUBA HAMPSONII, n. sp., Pl. II, Fig. 13, ♂.

♂. UPPERSIDE deep violet-purple, the outer margins of both wings narrowly black. UNDERSIDE pale brown, tinged with ochreous on the inner margin extending into the disc of the forewing, which wing bears the following blackish markings outwardly defined with white:—a quadrate spot across the middle of the cell with a small spot above it on the costa, a similar but larger one closing the cell, a discal curved chain of six spots (which is shifted inwards at the penultimate spot from the inner margin), and a submarginal series of lunules. *Hindwing* marked with some indistinct spots at the base, then four subbasal ones extending across the wing, one closing the cell, and a much curved and irregular discal series. Submarginal lunules as in forewing but bearing three black spots towards the anal angle, the outermost one large and prominent, the others small. No tail. The usual anteciliary black line; cilia pale brown, on the hindwing marked with dark brown at the ends of the nervules.

*Expanse* 1.15 inches.

HAB. Ootacamund, Nilgiri Hills, South India. In coll. G. F. Hampson and L. de Nicéville.

Nearest to the tailless *N. dana*, de N., which also occurs at Ootacamund, but differing on the upperside in being of a different colour (deep violet-purple instead of light bluish-purple), and on the underside in having the markings throughout darker and more conspicuous, and the ground-colour also darker. The forewing is also narrower and more produced at the apex.

CATAPÆCILMA BUBASES, Hewitson, Pl. II, Figs. 11, ♂ & 1, ♀.

*Hypochrysops bubases*, Hewitson, Ent. Month. Mag., vol. xii, p. 38 (1875).

♂. UPPERSIDE smoky purplish-black, obscurely shot with purple in some lights, the cilia blackish marked with white towards the anal angle

of the forewing and throughout the hindwing. Two very fine silvery lines on the margin at the anal angle. Tails black tipped with white. **UNDERSIDE** black, densely and evenly striated with chrome-yellow, and with scattered greenish-silvery metallic spots and streaks, which form a marginal series on both wings.

♀. **UPPERSIDE**, *forewing* pale blue, with the costa, the apex widely, and the outer margin blackish. *Hindwing* with all but the outer margin, which is blackish, pale blue. Towards the anal angle there is first a fine pale blue line, then a yellow one defined on both sides by a black one, and then another pale blue line. **UNDERSIDE** as in the male.

*Expanse* ♂ ♀ 1.25 inches.

**HAB.** Sikkim (*Otto Möller*), Malacca (*Hewitson*).

This is only the second known species of the genus recorded from India; the first (*C. elegans*, Druce) has a very wide range, occurring in Borneo (whence it was described), the Malay peninsula, Cachar (*Wood-Mason*), Ceylon, Cannanore, S. India (*Major-General Macleod*); Orissa (*W. C. Taylor*), and Sikkim (*Otto Möller*).

Hewitson's description of *C. bubases* is very meagre; a comparison of his Malaccan female type with Sikkim specimens may disclose specific differences.

**SATADRA SINGLA**, n. sp., Pl. II, Figs. 8, ♂ & 7, ♀.

♂. **UPPERSIDE** very dark shining purple, with a somewhat broad black margin. *Forewing* with a distinct black discocellular mark. **UNDERSIDE**, *forewing* brown, paler towards the inner margin, widely washed at the apex with pale violet, and bearing the following dark brown spots with pale margins:—a circular one towards the base of the cell, a large oval one just beyond its middle, and a quadrate one closing it, above the last a small spot on the costa, one filling the base of the interspace between the first and second median nervules, and a large one below and within the latter reaching the submedian nervure; a discal chain of seven spots, broken and inclined inwards at the fifth spot, a sub-marginal lunular band not reaching the apex, the margin dark brown. *Hindwing* pale brown, all but the bands and spots powdered with pale violet-whitish, giving it an unusual and peculiar appearance. The spots and bands arranged as in other species of this group, somewhat indistinct. The anal lobe rufous-brown (not black as in many species); in one specimen a few metallic-green scales above and beyond it. Tail of moderate length, pale brown, tipped with white.

♀. **UPPERSIDE**, *forewing* with a large patch of bluish-violet in the middle; *hindwing* with some traces of this colour in the cell and just

below it. **UNDERSIDE** with the ground-colour and markings paler throughout than in the male.

*Expanse* ♂ 1·8, ♀ 1·8 to 2·0 inches.

**HAB.** Sikkim.

Near to *Satadra bupola*, Hewitson, many specimens of both sexes of which species, also from Sikkim, are now before me. *S. singla* ♂ may be distinguished at once from that species by the much narrower and more produced forewing, by the colour of the upperside being of a much darker shade of purple, and both sexes by the violet-whitish powdering of the hindwing on the underside. Allied also to *S. silhetensis*, Hewitson, a female specimen of which from the typical locality is in the Indian Museum, Calcutta. On the upperside of the latter the violet-blue colour is far more extensive and lighter in shade, the underside is also uniform bright brown throughout, not powdered with violet-white as in *S. singla*.

**PLASTINGIA NOËMI**, n. sp., Pl. II, Fig. 15, ♂.

♂. **UPPERSIDE** black. *Forewing* with a fusiform chrome-yellow streak on the costa from the base to nearly half the length of the wing, a similarly-coloured streak placed below the median nervure and divided by the submedian into two unequal parts, the lower portion the smaller, extending to rather more than half the inner margin of the wing from the base; and with two or three subapical conjoined increasing spots, two lengthened spots at the end of the cell placed one above the other, the upper one the smaller, a triangular spot towards the base of the second median interspace, a much larger one towards the base of the first, all semi-transparent yellowish-white. *Hindwing* with a chrome-yellow patch placed in the middle of the disc just beyond the cell, and divided by the black nervules. **UNDERSIDE**, *forewing* black, the costa narrowly, the apex very widely, and a patch placed in the middle of the submedian interspace chrome-yellow. The semi-transparent spots as above. Five rounded small black spots placed in an outwardly-angled subapical series. *Hindwing* chrome-yellow; the margin increasingly to the anal angle, then decreasingly up the abdominal margin black. A subbasal spot, another at the end of the cell, a series of eight spots placed round the cell, all black. *Antennæ* black, the club yellow. *Thorax* and base of *abdomen* above clothed with long greenish-ochreous hairs, the rest of the abdomen black ringed with yellow, the thorax and *legs* beneath chrome-yellow.

*Expanse* 1·6 inches.

**HAB.** Sikkim (*Otto Möller* and *Dr. T. C. Jerdon*). In coll. Colonel A. M. Lang, collected by *Dr. T. C. Jerdon*.



Belongs to the same group as the *Hesperia callineura* of Felder (? = *Hesperia latoia*, Hewitson), but is quite distinct.

HALPE SITALA, n. sp., Pl. II, Fig. 5, ♂.

♂. UPPERSIDE, *forewing* dark brown; two minute conjoined subapical dots, two well-separated spots placed obliquely near the end of the cell, and two similar ones on the disc, semi-diaphanous ochreous-white. The usual sexual mark, somewhat indistinct. *Cilia* ochreous, dusky at the ends of the nervules. *Hindwing* dark brown, with a patch of ochreous hairs in the middle of the wing; *cilia* ochreous. UNDERSIDE, *forewing* dark brown, the costa and apex widely ferruginous-ochreous; the spots as above. *Hindwing* ferruginous-ochreous; two conspicuous white dots placed in the median interspaces, two indistinct ochreous spots placed close together between the innermost of the two spots and the anal angle. *Antennæ* dusky above, the club and upper portion of the shaft below ferruginous.

*Expanse* 1·5 inches.

HAB. Ootacamund, S. India (*G. F. Hampson*).

HALPE KUMARA, n. sp., Pl. II, Fig. 10, ♂.

♂. UPPERSIDE deep bronzey-brown. *Forewing* with five small equal-sized ochreous spots, *viz.*, two conjoined subapical, one at the upper and outer angle of the cell, and two on the disc. *Hindwing* unmarked. UNDERSIDE with the costa and apex diminishing towards the inner angle of the forewing and the entire hindwing clothed with deep ochreous scales; the spots of the forewing as above but larger. An anteciliary black line; *cilia* ochreous, dusky at the end of the nervules in the forewing. *Antennæ* dusky above, the club and upper portion of the shaft bright ochreous. The sexual mark on the upperside of the forewing indistinct.

*Expanse* 1·4 inches.

HAB. Sikkim (*Otto Möller*).

Allied to *Halpe separata*, Moore, a female specimen of which from Sikkim is before me. Differs from that species in having only two subapical spots, the spot in the cell not transverse, and the posterior border of the forewing on the underside dark brown, not yellow.

ISOTEINON PANDITA, n. sp., Pl. II, Fig. 14, ♂.

♂. UPPERSIDE brown, sparsely clothed with ochreous scales. *Forewing* with a quadrate transverse spot at the end of the cell, three conjoined subapical ones, and two similar discal ones, semi-diaphanous ochreous. *Cilia* ochreous. *Hindwing* immaculate. UNDERSIDE brown,

forewing with the apex widely and the costa and the entire hindwing ferruginous-ochreous. *Forewing* with the spots as above. *Hindwing* with a very indistinct small black spot at the end of the cell, and a discal series of similar short streaks between the nervules. *Cilia* ochreous. *Antennæ* black, the tip of the club, and the upper portion of the shaft below the club ferruginous.

*Expanse* 1·2 inches.

HAB. Sikkim (*Otto Möller*).

ISOTEINON FLAVIPENNIS, n. sp., Pl. II, Fig. 4, ♀.

♂ and ♀. UPPERSIDE brown, glossed with purple on the outer area of the forewing, the *hindwing* bearing a patch of long ochreous hairs in the middle of the disc and on the abdominal margin. *Forewing* with the following white semi-transparent spots:—a small round one in the middle of the upper discoidal interspace; two at the end of the cell, one above the other, the lower twice the size of the upper; a large spot in the interspace below and a small one placed in the second median interspace near its base. UNDERSIDE with the costa and apex widely and the entire hindwing ferruginous-ochreous glossed and marbled with purple, the disc of the forewing dark brown, the inner margin paler. *Forewing* with the spots as above; *hindwing* with a dark-brown spot in the cell and a series of five or six similar spots placed around the cell. *Cilia* cinereous, dark brown at the end of the nervules. *Antennæ* black, annulated with pale ochreous beneath, the club, all except the extreme tip, pale ochreous beneath.

*Expanse* 1·3 to 1·4 inches.

HAB. Buxa, Bhutan (*Moti Ram*), Sikkim (*Otto Möller*), and South Andaman Island (*A. de Roepstorff*).

THANAOS JHORA, n. sp., Pl. II, Fig. 12, ♂.

♂. UPPERSIDE dark brown; *cilia* whitish marked with brown at the ends of the nervules. *Forewing* with a discal curved series of about six pale dots. *Hindwing* unmarked. UNDERSIDE dark brown, the costa and the apex of the forewing and the entire hindwing greenish-ochreous. *Forewing* with the discal series of spots as above, and an indistinct marginal lunular series. *Hindwing* with a very irregular discal series of spots and an obscure marginal series.

*Expanse* ·95 to 1·05 inches.

HAB. Sikkim (*Otto Möller* and *de Nicéville*).

Nearest to *T. stigmata*, Moore (Pl. II, Fig. 2, ♂, from Masuri), which occurs commonly in Sikkim with it, and is the only species of the genus hitherto described which is furnished with a male sexual mark on the upperside of the forewing.

## THANAOS KALI, n. sp., Pl. II, Fig. 3, ♂.

♂. UPPERSIDE deep purplish-black, the *cilia* cinereous. UNDERSIDE slightly paler. *Forewing* with a discal outwardly-angled series of eight pale violet-white dots, an even somewhat larger marginal lunular series. *Hindwing* with a discal irregular series of pale violet-white spots, within which are some obscure pale markings; a marginal series as in the forewing. *Cilia* cinereous, marked with dark brown at the ends of the nervules.

*Expanse* 1.15 inches.

HAB. Sikkim (*Otto Möller* and *de Nicéville*).

This is a very distinct species.

## PLESIONEURA NIGRICANS, n. sp., Pl. II, Fig. 6, ♀.

♂ and ♀. UPPERSIDE swarthy, slightly sprinkled with ochreous scales on the basal half of the forewing. *Forewing* with an oblique semi-diaphanous pure white band across the disc composed of three conjoined spots, the middle one at the base of the interspace between the first and second median nervules the smallest, elongated, and projecting beyond the outer margin of the other two spots; a small similar spot placed below the lower outer angle of the third spot, and an opaque spot placed above the uppermost spot not quite reaching the costa; and with a recurved series of from three to five dots before the apex. *Hindwing* with the basal and abdominal areas sparsely clothed with long ochreous hairs. UNDERSIDE, *forewing* as above, but the lowest spot of the discal band much larger, its inner margin straight, its outer margin blurred. *Hindwing* with an indistinct ochreous spot at the end of cell, and submarginal series of similar spots, the two towards the anal angle rather more distinct than the others. The base and abdominal area somewhat ochreous. *Cilia* dusky on the forewing excepting a small portion towards the inner angle which is ochreous; dusky also on the hindwing, with three ochreous spots below the outer angle, and one towards the anal angle. *Antennae* blackish, the underside of the club and a small portion of adjoining shaft pure white.

*Expanse* 1.7 inches.

HAB. Sikkim (*Otto Möller*), Buxa, Bhutan (*Moti Ram*).

## EXPLANATION OF PLATE II.

- Fig. 1 *Catapœcilma bubases*, Hewitson, ♀.  
 „ 2 *Thanaos stigmata*, Moore, ♂.  
 „ 3 „ *kali*, ♂, n. sp.  
 „ 4 *Isoeteinon flavipennis*, ♀, n. sp.  
 „ 5 *Halpe sitala*, ♂, n. sp.



- Fig. 6 *Plesioneura nigricans*, ♀, n. sp.  
,, 7 *Satadra singla*, ♀, n. sp.  
,, 8 ,, ,, ♂, n. sp.  
,, 9 *Symbrenthia silana*, ♂, n. sp.  
,, 10 *Halpe kumara*, ♂, n. sp.  
,, 11 *Catapæcilma bubases*, Hewitson, ♂.  
,, 12 *Thanaos jhora*, ♂, n. sp.  
,, 13 *Nacaduba hampsonii*, ♂, n. sp.  
,, 14 *Isoteinon pandita*, ♂, n. sp.  
,, 15 *Plastingia noëmi*, ♂, n. sp.
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XI.—“*The Swatch of no Ground*”.—By Commander ALFRED CARPENTER, R. N., in charge of Marine Survey of India. Communicated by the NATURAL HISTORY SECRETARY.

[Received June 6th ;—Read July 1st, 1885.]

The Bay of Bengal, the entrance to which between Ceylon and the Nicobar Islands has a depth of some 2000 fathoms, gradually shoals northward to the 19th parallel of latitude, where it has a depth of about 1400 fathoms. In the next 60 miles northward, the head of the Bay shoals rapidly, as might be expected when it is entered by such rivers as the Ganges and the Brahmaputra.

The particles of mud discharged by a river debouching through a flat delta are very minute and are held in suspension for days. It is these which slowly settling form here a bank of olive-coloured mud and grey sand. If we now look at a chart of the Bay of Bengal and examine the mouths of this great delta and the shoals formed off them, we shall notice with surprise that the direction of every channel through these shoals is such as to tend to throw the ebbing waters towards the region called the Swatch. This is especially noticeable in Chart 829 Coconada to Bassien river.

Presuming then that this tendency is actually followed by the ebbing water, the result is a number of whirls and eddies just in that locality, the position of the Swatch being central with regard to the deltaic mouths.

The condition necessary to admit of mud in suspension settling to the bottom is perfect quiescence of the supporting medium. This never occurs here during the ebb tides. During the flood, which only lasts 5 hours against 7 hours' ebb, the water is only muddy for the first hour, while the outflow partly returns; the green ocean water then comes in carrying little or nothing in suspension. In this region, then, we have only one hour's settle of mud against 6 hours or 7 hours over the adjoining banks. During the course of ages the banks on either side have grown seaward and their southern face falls abruptly into deep water. But in the Swatch the banks have never been able to meet and the depth still remains considerable.


This submarine ravine is 1800 feet deep at 15 miles from the flat mangrove islands of the delta, whilst at that distance off shore the bank on each side of the Swatch is only 100 feet below water.

The ‘Investigator’ in the Spring of this year, 1885, re-sounded the whole bank of soundings from False Point to the Mutla river entrance. Compared with the surveys of some forty years ago there has been

remarkably little change, but close off the Rivers Hughly and Mutla the banks have extended southward over a mile.

When the 'Investigator' trawled in the Swatch last March the bottom mud was found to be exceedingly soft, and consisted of a dark green ooze largely mixed with shells of pteropods. Life here was comparatively scarce, only some annelid worms in muddy tubes and some bivalve shells being found in the deeper portions, though at the sides, on the sloping banks, several fish, *Macrurus* and small sharks, and some shrimps and several other species of Crustacea were found. The mouth of the Swatch rises somewhat rapidly from about 900 to 600 fathoms with a bottom temperature of  $43^{\circ}7$  Fahrenheit. This is a little above the average of open seas at corresponding depths, but, considering that it is in Lat.  $20^{\circ}$  N. and that the water has presumably come from the Antarctic Ocean, the difference is intelligible. The depth of 600 soon decreases to 450 fathoms, at which depth a channel runs nearly up to the head of the Swatch and carries the cold water northward, for at 100 fathoms at the head the temperature was as low as  $56^{\circ}$  though the surface at the same time shewed  $81^{\circ}$ .

The temperature at the bottom between the Andamans and Ceylon in 2100 fathoms is only  $33^{\circ}7$  Fahr. corrected, this being in Lat.  $8^{\circ}$  N. There is probably a deep valley trending up the west centre of the Bay of Bengal, and the 'Investigator' will annually add to our information of its configuration. The position of the Swatch would be about in the continuation of this valley, which is the main line of depression between India and Burma, its northern extension being now filled with deltaic deposits. Although the actual ground of the Swatch is of these same deposits, and so of comparatively recent formation, the feature is in a great measure due to the conflict of the same terrestrial waters, to the erosive action of which in bygone times the rock-valley itself must be in part attributed.





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## ASIATIC SOCIETY OF BENGAL.

### Part II.—NATURAL SCIENCE.

#### No. III.—1885.

#### XII.—Notes on Indian Rhynchota. No. 4.—By E. T. ATKINSON, B. A.

[Received July 7th;—Read August 5th, 1885.]

##### Family FULGORIDÆ, Leach.

Edin. Ency. ix (1817); Westwood, Mod. Class. Ins. ii, p. 427 (1840); Fieber, Verh. Zool.-Bot. Gess. Wien, xvi, p. 497 (1866):—*Fulgorellæ*, Latr. Gen. iii, p. 163 (1807); Spinola, A. S. E. F. (1 sér.) viii, p. 133, 202 (1839):—*Fulgorina*, Burm., Handb. Ent. ii (i) p. 102, 144 (1835):—*Fulgorida*, Stål, Hem. Afric. iv, p. 128 (1866).

Two ocelli, rarely three or none, one on each gena; third, when present, placed on the apex of the frons: genæ reflexed, very often separated from the frons by a ridge: tegmina at the base with a tegula, which is seldom wanting, hidden: anterior coxæ inserted near the sides of the body, very often elongate; last pair, transverse, contiguous, extended to the lateral margins of the body (*Stål*).

##### Subfamily FULGORINA, Stål.

*Fulgorides*, Am. & Serv., Hist. Nat. Ins. Hém. p. 488 (1843). *Fulgorida*, Stål, Hem. Afric. iv, p. 129 (1866), Stettin Ent. Zeit. xxxi, p. 255, 282 (1870); *Fulgorina*, Stål, Ofvers. K. V.-A., Förh. p. 740 (1870).

Anal area of wings reticulated; the ridge separating the frons from the genæ is continued in the sides of the clypeus (*Stål*).

##### Genus FULGORA, Linnæus, Stål.

*Fulgora*, Stål, Hem. Afric. iv, p. 133 (1866); *Hotinus*, Am. & Serv., Hist. Nat. Ins. Hém. p. 490 (1843); Walker, List Hom. B. M. ii, p. 264 (1851).

Vertex much broader than the eyes: head furnished with a long process, rounded or subtetragonal: genæ truncated before the eyes: frons slightly sinuated at the apex, furnished with 2—3 longitudinal ridges: feet slender: scutellum slightly carinated; cephalic process more or less curved (*Stål*).

A. Section with (when dead) orange wings.

1. *FULGORA CANDELARIA*, Linnæus.

*Cicada candelaria*, Linn., Acta Holm. p. 63, t. 1, f. 5, 6 (1746); Roesel von Rosenhof, Ins. Belust. 2, Gryll. p. 189, t. 30 (1749); Sulzer, Ins. t. 10, f. 62 (1761).

*Laternaria candelaria*, Linn. Mus. Lud. Ulr. p. 153 (1764).

*Fulgora candelaria*, Linn. Syst. Nat. i (2) p. 70 (1766); De Géer, *Cigale chinoise porte-lanterne*, Ins. iii, p. 197 (1773); Fabricius, Syst. Ent., p. 673 (1775); Spec. Ins. ii, p. 313 (1781); Gmelin, ed. Syst. Nat. i (4) p. 2089 (1782); Fabr. Mant. Ins. ii, p. 260. (1787); Ent. Syst. iv, p. 2 (1798); Syst. Rhynch., p. 2 (1803); Olivier, Enc. Méth. vi, pp. 568, 593, t. 109, f. 3 (1790); Stoll, Cigales, (*Cigale Chinoise*), p. 44, t. 10, f. 46 A. (1788); Burmeister, Handb. Ent. ii (i) p. 168 (1835); Westwood in Donovan's Insects China, t. 14, (1842); Trans. Linn. Soc. XVIII, p. 138 (1841); Blanchard, Hist. Nat. Ins. Hém. t. 12, f. 1 (1840-41); Butler, P. Z. S. p. 97 (1874).

*Flata candelaria*, Germar, Mag. iii, p. 189 (1818).

*Pyrops candelaria*, Spinola, A. S. E. F. viii, p. 238 (1839).

*Hotinus candelarius*, Am. & Serv., Hist. Nat. Ins. Hém. p. 490 (1843); Walker, List. Hom. B. M. ii, p. 265 (1851).

Head produced in a horn, as long as the body, subulate, ascending, obtuse, somewhat compressed, subangulate, red, sprinkled with milk-white spots: eyes subglobose, a globose pellucid dot beneath the eyes: antennæ beneath the eye, very short, two-jointed, lower joint cylindrical, upper subglobose, fuscous, ending in a very small seta: thorax testaceous, like the three-cornered scutellum; abdomen, above fulvous, beneath black, with luteous margins: tegmina fuscous, reticulated green and adorned with various luteous spots margined with whitish of which the first band is transverse and the second cruciform, the rest round: wings luteous, broadly black towards the apex: feet flavescent, first and second tibiæ black, third denticulate (*Linn. M. L. U.*). Long 40—45; cephalic process 15—20 millims.

Reported from China, Cambodia, India. The Indian Museum possesses specimens from Sikkim, Assam. The next three appear to be little more than local varieties of *F. candelaria*.

2. *FULGORA BREVIROSTRIS*, Butler.

*Fulgora brevirostris*, Butler, Proc. Zool. Soc. p. 97, 1 t. xv, f. 1, (1874).

Closely allied to *F. candelaria*; tegmina black, with the veins and spots bright ochraceous, disposed as in *F. candelaria*; wings orange-ochreous, the apical third black; cephalic process short, curved, ascend-

ing, testaceous with paler spots : prothorax much compressed in front, with a central longitudinal ridge and two strongly impressed black punctures, testaceous, with a black lateral patch ; the rest of the body, luteous above, mesothorax maculated with black ; abdomen below black, the margins of the segments testaceous ; legs pitchy ; the coxæ and the femora of the last pair, dirty testaceous (*Butler*). Body long with cephalic process 29—30 ; cephalic process 13 and exp. teg. 63 millims.

Reported from India, Penang : the Indian Museum possesses a specimen from Sikkim (?).

### 3. *FULGORA VIRIDIROSTRIS*, Westwood.

*Fulgora (Hotina) viridirostris*, Westwood, Cab. Or. Ent. p. 8, t. 3, f. 4, (1848).

*Hotinus viridirostris*, Walker, Cat. Hom. B. M. ii, p. 265 (1851).

*Fulgora viridirostris*, Butler, P. Z. S. p. 98 (1874).

Cephalic process about half as long again as the thorax with the apex turned up and acuminate, of a dark green colour with white irrorations ; body fulvous, the thorax spotted with black ; feet black with the four anterior femora pitchy and the two hind femora, fulvous : tegmina and wings marked as in *F. candelaria* (*Westw.*). Body with cephalic process long, 32—38 ; exp. teg. 63—76 millims.

Reported from Assam : the Indian Museum possesses specimens from Sibságar (Assam) and Sikkim, the latter, as a rule, smaller with the cephalic process of a lighter green and the white irrorations thereon hardly visible.

### 4. *FULGORA SPINOLÆ*, Westwood.

*Fulgora (Pyrops) spinolæ*, Westwood, A. M. N. H., ix, p. 118 (1842).

*Fulgora (Hotina) spinolæ*, Westwood, Cab. Or. Ent. p. 73, t. 36, f. 1 (1848).

*Hotinus spinolæ*, Walker, Cat. Hom. B. M. ii, p. 266 (1851).

*Fulgora spinolæ*, Butler, P. Z. S. p. 98 (1874).

Cephalic process as long as the body with the apex turning up, above black, beneath luteous : body fulvous : anterior margin and the middle of the pronotum, a broad median stripe on the mesonotum, two dots and two oblique, lateral streaks, all black : tegmina brown, veins fulvous ; three straight, transverse, bands before the middle and six or seven sub-apical circular spots (of which some form an interrupted maculate band) palely fuscous ; wings, fulvous, black at the apex (*Westw.*). Body with cephalic process long 44 ; exp. teg. 82 millims.

Reported from Mysore, Assam, Silhat : the Indian Museum possesses specimens from Shillong, Nága hills, Silhat, Sibságar, and Sikkim.

### 5. *FULGORA LATHBURI*, Kirby.

*Fulgora lathburii*, Kirby, Trans. Linn. Soc. xii, p. 450 (1818) ; Westwood, *ibid.*, xviii, p. 139 (1841) ; White, A. M. N. H. xiv, p. 425 (1844) ; Guérin, Icon. Règne An. Ins. t. 58, f. 2 (1830-34) ; Butler, P. Z. S. p. 98 (1874).



*Flata lathburii*, Germar, Thon's Archiv. ii, (2), p. 46 (1830).

*Hotinus lathburii*, Walker, Cat. Hom. B. M. ii, p. 266 (1851).

Allied to *F. candelaria*, Linn., cephalic process ascending, above black, apex red: dorsum of thorax black: tegmina blackish-green, sprinkled with many ocellate spots having a luteous pupil and a white iris; some white dots on the interior margin: abdomen pallid, spotted black: wings luteous, black at the apex (*Kirby*). Long, 38 millims.

Reported from China, Silhat.

To this section also belong:—

*F. cyanirostris*, Guérin, A. S. E. F. (2 Ser.) iii, Bull. Ent. p. xovi, (1845). Java.

*F. nigrirostris*, Walker, Ins. Saund. p. 29 (1858). Siam.

*F. philippina*, Stål, Ofvers. K. V.-A., Förh. p. 740 (1870). Philippines.

*F. æruginosa*, Stål, l. c. p. 741 (1870). Philippines.

*F. lauta*, Stål, l. c. p. 741 (1870). Philippines.

## Sec. 2. *Species with whitish or white and red wings.*

### 6. *FULGORA CONNECTENS*, n. sp.

The coloration of the tegmina connects this fine species with the first section and that of the wings places it in this section. Cephalic process much longer than the body, ascending, much recurved, somewhat sabreshaped, much compressed, much flattened at the apex, black above, greenish-fulvous beneath, signs of faint white irrorations above: thorax black, with a broad, transverse, fulvous band concolorous with the intermediate coxæ and the clypeus: abdomen above sordid fulvescent, beneath black with each segment broadly bordered posteriorly with sordid fulvescent; anus black: feet black, coxæ, intermediate femora above, and entire posterior femora, brown: tegmina black, veins greenish; the basal half with three transverse fulvous bands, of which the third from the base becomes a confluent row of four round fulvous spots, ocellated paler, beyond this in the apical half comes a transverse row formed of two large fulvous ocellated confluent spots near the costal margin and a smaller spot not ocellated near the interior margin, then another interrupted transverse row commencing with four ocellated confluent spots at the costal margin and ending with two confluent ocellated spots at the internal margin; two large and two small fulvous spots not ocellated in the apical fourth: wings white, apex black, with three confluent white spots and two smaller within the black part. Body long to the eyes, 22; cephalic process long from eyes to tip, 30: exp. teg. 80 millims.

The Indian Museum possesses a specimen from Tenasserim.

### 7. *FULGORA CLAVATA*, Westwood.

*Fulgora clavata*, Westwood, Trans. Linn. Soc. xviii, p. 139, t. 12, f. 1 (1841); Cab. Or. Ent. p. 7, t. 3, f. 1 (1848); Butler, P. Z. S. p. 98 (1874).

*Hotinus clavatus*, Walker, Cat. Hom. B. M. ii, p. 267 (1851).

Cephalic process and head piceous, covered with a white-farinoso substance, as long as half the body, gradually attenuated from the base, its dorsum tricarinate and apex turning upwards and ending in a knob or ball sub-rounded, sub-pellucid, and broadly testaceous: thorax luteous, pronotum with two minute discoidal, black, dots; mesonotum with four basal and two other oblique lateral spots: abdomen beneath fulvous, above obscure, dotted with a white farinoso substance, apices of segments luteous, anus black: basal half of tegmina somewhat whitish with numerous, irregular fuscous spots; apical half fuscous with numerous whitish circular spots, varying very much in size and most of them ocellated: wings somewhat whitish, apex broadly fuscous: feet and rostrum black; clypeus luteous (*Westw.*). Body with cephalic process long  $33\frac{1}{2}$ ; exp. teg. 76 millims.

Reported from Assam: the Indian Museum possesses specimens from Sikkim, Khasiya Hills, Sibságar, Shillong. In fresh specimens the whole of the tegmina and abdomen above and below is thickly covered with a white powdery substance: the abdomen, too, is of a rich red colour, which fades to fulvous, and the wings at the base are a light blue, which fades to grey. The Indian Museum possesses a remarkable local variety from Mussooree in which the entire cephalic process is dull red and the ground of the tegmina is much lighter.

#### 8. *FULGORA PONDEROSA*, Stål.

*Hotinus ponderosus*, Stål, Ofvers. K. V.-A. Förh. xi, p. 244 (1854): Walker, Cat. Hom. B. M. Suppt. p. 315 (1858).

*Fulgora ponderosa*, Butler, P. Z. S. p. 98 (1874).

Cephalic process half the length of the body, cylindrical, black-piceous, ascending at the apex, which is testaceous: thorax and scutellum yellow-testaceous, the latter with four basal spots and two behind the middle, black: tegmina sordid white, sparingly covered with a white farinoso substance; a median band spotted with white; and two spots at the anterior margin before the middle and one at the sutural margin, black; several fuscous spots on the disc and apex, which is spotted white: wings sordidly whitish subhyaline, weakly fuscous at the apex: abdomen yellow testaceous, segments margined testaceous: feet and rostrum black; posterior femora yellow-testaceous beyond the middle (*Stål*). Body long, 38: exp. teg. 88 millims.

Reported from India. There is little doubt that this is merely a variety of *F. clavata*, *Westw.*

#### Sec. 3. *Species with red and whitish wings.*

#### 9. *FULGORA OCLATA*, Westwood.

*Fulgora oculata*, Westwood, Trans. Linn. Soc. xviii, p. 142, t. 12, f. 5 (1841); Butler, P. Z. S. p. 99 (1874).

Var. *a. Fulgora (Hotina) oculata*, Westwood, Cab. Or. Ent. p. 73, t. 36, f. 2 (1848).

Var. *b. Fulgora subocellata*, Guérin, Rev. Zool. p. 183, (1839); Delessert, Souv. Voy. Inde, p. 66, t. 16, f. 1 (1842); Butler, P. Z. S., p. 99, (1874).

*Hotinus oculatus*, Walker, Cat. Hom. B. M. ii, p. 267, (1851).

*Hotinus subocellatus*, Walker, l. c. p. 267, (1851); J. L. S. Zool. i, p. 84, (1856).

Cephalic process as long as the body, ascending, slender: pale greyish-fulvous, abdomen and wings clothed with a fine white powdery substance, mesothorax more fulvescent: tegmina greyish fulvous, pale, with about twenty-four ocellated spots, fulvous rings girdled whitish: wings white-farinose, palely virescent at the base with the anterior margin having a large roseate patch in the middle ending in a fuscous spot and another smaller towards the middle: feet palely greyish-luteous; four anterior tibiae and tarsi and the last tarsi, black (*Westw.*) Long with cephalic process 35; exp. teg. 63 millims.

Reported from India.

Var. *a.* Cephalic process as long as the body, ascending at the apex, brunneous; body greyish luteous, powdered with a white farinose substance: tegmina greyish fulvous, each with 24-30 fulvous ocellated spots, encircled with buff; wings clothed with a white powdery substance, the base pale green, middle of the costa marked with a large rosy patch and followed by a brown streak which is sometimes extended over the whole apex of the wing which is, in such case, marked with several paler spots; legs luteous, the four anterior tibiae and tarsi and the two hind tarsi, black (*Westw.*) Exp. teg. 65-87 millims.

Reported from Malabar, Penang.

Var. *b.* Cephalic process as long as the body, ascending at the apex, obscurely ferruginous above, green beneath: body and feet green, anterior and intermediate tibiae black; tegmina fulvescent green, subocellated yellow: wings white somewhat green at the base, clothed with a white powdery substance and spotted on the anterior margin with black and ferruginous (*Guérin*). Long, 48; exp. teg., 93 millims.

Reported from Nepál, Penang, Malacca. Guérin keeps this separate as he considers that *F. oculata*, West. is smaller, the spots on its tegmina are tawny, very restricted and surrounded by whitish on grey-tawny ground and its wings are also adorned with a great rosy patch, tipped with brown; characters wanting in his *F. subocellata*. Still comparing the wide differences in the extreme varieties of *F. clavata* this variety cannot at present receive specific rank.

Var. *c.* Spots on the tegmina confluent and of a rosy colour: the green at the base of the wings absent. Var. *verhuelli*.

This section includes also the following:—

*F. sultana*, Adams, P. Z. S. p. 83 (1847). Borneo.

*F. gigantea*, Butler, P. Z. S. p. 99 (1874). Borneo.



C. *Species with blue-green wings.*10. *FULGORA AMPECTENS*, n. sp.

This species forms the connecting link between the preceding section and this; the coloration of the tegmina strongly resembles that of the *F. oculata* group and the coloration of the wings places it in this section. Cephalic process as long as the body, somewhat horizontal, gradually ascending somewhat towards the tip, subrotundate above and subequal in size throughout, black-brown throughout, above and beneath, except the tip which is reddish-testaceous and subpellucid, apical half below the tip irrorated with white dots: thorax deep brown, blacker on the disc: abdomen above and beneath, black; posterior margins of the dorsal segments narrowly fulvous: feet brown throughout: tegmina brown, veins fulvous, basal two-thirds finely covered with a white powdery substance above and bright fulvous beneath, this white powdery substance intensified across the base of the apical third so as to form a white band which bears a row of four fulvous spots, a small one and the largest towards the costal margin and two small ones towards the internal margin, four or five very faint similar fulvous spots and very numerous light brown spots are sprinkled over the basal two-thirds: wings blue, apex broadly and external margin less broadly, black, rayed black along the veins towards the base somewhat as in *F. pyrrhorhyncha*, Don., to which this species is very closely allied, differing chiefly in the coloration of the abdomen and the size, arrangement, and number of the spots on the tegmina. Body long to eyes, 24; cephalic process from eyes, 23; exp. teg. 93 millims.

The Indian Museum possesses a specimen from Perak.

11. *FULGORA PYRRORHYNCHA*, Donovan.

*Fulgora pyrrorhynchus*, Donovan, Ins. Ind. Hem. t. 7, f. 1 (1800): Règne Animal ed. Masson, t. 96, f. 2 (n. d.).

*Hotinus pyrrorhynchus*, Walker, List Hom. B. M. ii, p. 267 (1851); J. L. S. Zool. x, p. 96 (1867).

*Fulgora pyrrorhina*, Westwood, Trans. Linn. Soc. xviii, p. 139 (1841); in Donovan's Ins. Ind. (2nd ed.) p. 13 (1842).

*Fulgora rajah*, Guérin, Rev. Zool. p. 183 (1839).

*Fulgora pyrrorhyncha*, Butler, P. Z. S. p. 100 (1874).

Cephalic process large, of a dark purple, thickly sprinkled with a white powdery substance, ascending, tip scarlet and somewhat pellucid: tegmina brown, pale across the middle; wings black, green at the base (*Donovan*).

Cephalic process about 25 millims; long, purple, spotted white, ascending; apex incrassated, red; dorsum of abdomen greenish with three black spots on the anterior margin of each segment; lateral mar-

gins of thorax and basal margin of scutellum somewhat testaceous : tegmina brown, spotted pale glaucous, and with a paler band, basal half with eleven irregularly placed, round, yellow spots, a pale band with a transverse row of four round spots of a deeper colour approaching fuscous and slightly margined inwardly with yellow and the apical fourth has eight smaller round yellow spots. Guérin describes his *F. rajah* as having the cephalic process as long as the body, ascending, brunneous, apex somewhat dilated, red : body and feet brunneous ; tegmina blackish fulvous, spotted with yellow, a broad pallid band at the apex : wings black, blue at the base. Long, 44 millims.

Reported from Nepál (*Don.*) ; Malacca (*Guér.*).

## 12. *FULGORA MACULATA*, Olivier.

*Fulgora maculata*, Olivier, Enc. Méth. vi, p. 568 (1791) ; Stoll, (*La Cigale verte porte-lanterne*) Cigales, p. 98, t. 26, f. 143 (1788) ; Burm. Handb. Ent. ii, (i) p. 169 (1835) ; Westwood, Trans. Linn. Soc. xviii, p. 140 (1841) ; Duncan's Nats. Lib. 1, p. 284, t. 23, f. 2 (1840) ; Butler, P. Z. S. p. 100 (1874).

*Flata maculata*, Germar, Thon's Archiv. ii, fasc. 2, p. 46 (1830).

*Hotinus maculatus*, Walker, Cat. Hom. B. M. ii, p. 266 (1851).

Cephalic process almost as long as the body, ascending, recurved ; head black ; eyes and antennæ grey ; thorax brown, shaded with black : abdomen light brown, banded with black, same above and beneath ; tegmina above black with interrupted bands or continuous rows of glaucous spots, apical portion irrorated yellowish-green : wings with the basal portion towards the anterior margin and a patch near the anal margin, greenish-blue ending in fine rays, apical portions black : feet deep brown, posterior pair spinose. Body long to the eyes, 21 : cephalic process from the eyes 19 ; exp. teg. 71 millims.

The Indian Museum possesses a specimen from Ceylon.

## 13. *FULGORA FULVIROSTRIS*, Walker.

*Hotinus fulvirostris*, Walker, List Hom. B. M. Suppt. p. 41 (1858).

Butler (P. Z. S. p. 100, 1874) unites this species with *F. maculata*, Olivier, as a variety, but it is as much entitled to specific rank as *brevirostris*, *viridirostris*, and *spinolæ*, which are similar varieties of *F. candelaria*, Linn. It clearly differs from *F. maculata* in having the cephalic process subpellucid, sordid fulvous-testaceous or tawny instead of opaque deep green ; the markings on the tegmina follow the arrangement of the markings on the tegmina in *F. maculata*, but are sordid whitish instead of bluish-white, and the wings are sordid greenish-white rayed with black-fuscous nearly up to the base, the apex being broadly and the external margin less broadly black.

Black : head tawny, cephalic process abruptly curved and ascending, a little shorter than the body, blackish on each side, at the base : pronotum with some dingy whitish or testaceous marks on each side : mesonotum more or less testaceous or whitish on the disc ; hind border and abdomen whitish or testaceous, the latter with some irregular and incomplete blackish bands : tegmina with about 20 whitish or straw-coloured spots and dots, some of them connected, forming four very irregular bands : wings white or dingy whitish towards the base (*Walker*). Body long, 27 ; cephalic process from the eyes, 20 ; exp. teg. 59 millims.

Reported from Ceylon : the Indian Museum possesses two specimens from Ceylon. It is possible that we should place this and the two next as varieties of *F. maculata*.

#### 14. *FULGORA DELESSERTII*, Guérin.

*Fulgora delessertii*, Guérin, Rev. Zool. p. 183 (1839) ; Delessert, Souv. Voy. Inde, pt. ii, p. 66, t. 16, f. 2 (1843) ; Butler, P. Z. S. p. 100 (1874).

*Hotinus delessertii*, Walker, Cat. Hom. B. M. ii, p. 266 (1851).

Cephalic process half the length of the body, ascending, green : prothorax ferruginous : tegmina greenish black, spotted with yellow : wings cærulean, black at the apex (*Guérin*). Long 34 ; exp. teg. 75 millims.

Reported from the Nilgiris, Malabar.

This species is near to *F. maculata*, Olivier, but differs from it in the coloration of the spots on the tegmina. It differs from *F. candelaria*, Linn. "par les deux facettes latérales de la face frontale qui ont à leur extrémité une carène longitudinale allant du sommet des faces latérales au sommet de la tête." The cephalic process is short and compressed.

#### 15. *FULGORA ANDAMANENSIS*, Distant.

*Fulgora andamanensis*, Distant, Trans. Ent. Soc. p. 152, t. 5, f. 7, 7 a (1880).

Cephalic process long, slender, ascending, as long as the body ; beneath greenish luteous with the apex black, above black, apical two-thirds irrorated with small white spots and a luteous streak on each side within the eyes, which are also luteous ; thorax above black, with dull luteous markings ; abdomen above pale greenish-luteous, beneath black ; coxæ, trochanters, and femora fuscous, the last darkest, tibiae and tarsi, black. Tegmina black, with the veins pale green and a number of brown spots encircled with pale greenish, arranged thus :—a transverse row of four near the base, the upper three fused together ; two irregular transverse rows on the disc, a little nearer together than from the basal row, followed by a straighter transverse row of three smaller ones ; remaining apical portion occupied by about twelve spots of which the largest are two fused together on the costa and one with a very small



brown centre about the apex of the inner margin: extreme apical spots very small and somewhat indistinct. Wings blue with the apex broadly, and outer margin somewhat narrowly, black. The veins on the blue portion of the wings are green, with the exception of two which are narrowly black at the base (*Distant*.) Long, cephalic process 20; body 20; exp. teg. 68 millims.

Reported from the Andaman Islands.

Allied to *F. delessertii*, Guérin, and *F. maculata*, Olivier. It somewhat resembles the former in the pattern of the tegmina, but differs in the length of the cephalic process, which in *F. delessertii* is but about half the length of the body. In length and structure of the cephalic process, it is more closely allied to *F. maculata*; the cephalic process, however, is longer than in that species, being about equal to the length of the body; and, besides the different pattern of the tegmina, the wings are much more narrowly black along the posterior margin. The Indian Museum possesses a specimen from the Nicobar islands which appears to differ from the type figured by Distant in the cephalic process being longer, more distinctly ascending and recurved, and in the absence of white spots on the upper two-thirds. The markings on the tegmina are the same and do not differ more than individuals of allied species differ from each other. The wings are marked much as in *F. delessertii* Guérin, the outer margin is more broadly suffused with blackish than in the type and the blackish extends further towards the base in rays.

#### 16. FULGORA CURTIPRORA, Butler.

*Fulgora curtiprora*, Butler, A. M. N. H. (4 ser.) xiv, p. 131, (1874).

Closely allied to *F. gemmata*, West., but with the cephalic process one-third shorter and the colouring different: tegmina with the corium bright green speckled with black, area beyond black; the veins green, becoming ochraceous near the apex; entire surface covered with small orange spots: wings shining black, varied with pale transparent green as in *F. gemmata*: cephalic process, head, and thorax testaceous, thorax spotted with black; abdomen black, segments edged with green above, with ochreous below; legs and anus red (*Butler*). Body long with cephalic process, 23; cephalic process, long  $8\frac{1}{2}$ ; exp. teg. 50 millims.

Reported from Sikkim.

#### 17. FULGORA GUTTULATA, Westwood.

*Fulgora (Pyrops) guttulata*, Westwood, A. M. N. H. ix, p. 119 (1842).

*Fulgora (Hotina) guttulata*, Westwood, Cab. Or. Ent. p. 8, t. 3, f. 3 (1848).

*Pyrops guttulata*, Walker, List Hom. B. M. ii, p. 269 (1851).

*Fulgora guttulata*, Butler, P. Z. S., p. 101 (1874).

Cephalic process about half as long as the thorax, its apex slightly bent upwards and acute; head and thorax above of a fulvous clay-colour dotted with black: segments of the abdomen brown at the base: tegmina pale fulvous clay-coloured, gradually assuming a redder tinge beyond the middle with a great number of small pale buff dots edged with a black ring, the wings very pale yellowish, with a few black dots and a broad dark brown margin (*Westw.*) Body long with cephalic process, 25; exp. teg. 50 millims.

Reported from N. India.

The rostrum is very long and slender and extends to the end of the body, separated from the genæ by a transverse raised line, between which and the eyes is a black dot. The four anterior legs have a black ring at the base of the tibiæ, the apex of which and the tarsi are also black, the underside of the body and the hind legs are entirely fulvous with two small black spots at the base of the coxæ and two long black spots at the sides of the penultimate abdominal segment.

### 18. *FULGORA GEMMATA*, Westwood.

*Fulgora (Hotina) gemmata*, Westwood, Cab. Or Ent. p. 7, t. 3, f. 2 (1848).

*Hotinus gemmatus*, Walker, Cat. Hom. B. M. ii, p. 267 (1851).

*Fulgora gemmata*, Butler, P. Z. S. p. 101 (1874).

Head and thorax fulvous with black markings; abdomen above black with posterior margins of the segments narrowly green; tegmina green at the base which gradually changes into a dark brownish crimson; they are entirely covered with minute black dots, each tegmen being ornamented with about 30 bright orange spots; the wings are green, with a broad black border, which extends into the disc of the wing, forming several large, black blotches; legs, dark red (*Westw.*) Body long exclusive of cephalic process, 19; exp. teg. 28 millims.

Reported from Himálaya, N. India, Darjiling: the Indian Museum possesses specimens from Sikkim, Khasiya Hills, Assam. There is also a specimen in which the orange spots on the tegmina are obsolete and are replaced by roundish black rings with the centre of the ground colour of the tegmina; the wings are precisely the same.

To this section also belong the following species:—

*F. ducalis*, Stål, Trans. Ent. Soc. (3 ser.) i. p. 576 (1863). Cambodia.

*F. cælestina*, Stål, l. c. p. 576 (1863). Cambodia.

*F. intricata*, Walker, J. L. S. Zool. i, p. 132 (1857). Borneo.

*F. stellata*, Butler, P. Z. S. p. 100 (1874). Borneo.

Sec. D. *Species with scarlet wings.*19. *FULGORA CARDINALIS*, Butler.

*Fulgora cardinalis*, Butler, A. M. N. H. (4 ser.) xiv, p. 131 (1874).

Tegmina yellowish-olivaceous, veins and costal area bright green; entire surface covered with black-edged orange spots, arranged as in *F. virescens*, West., but larger and better defined; outer margin brown: wings carmine; outer margin brown, broadest at the apex: cephalic process, head and prothorax above, and the entire pectus green, spotted with black; meso- and meta-thorax testaceous, black-spotted; abdomen above reddish, below testaceous, varied with emerald-green: legs emerald-green (*Butler*). Body including cephalic process, 25; cephalic process  $8\frac{1}{2}$ : exp. teg. 53 millims.

Reported from Nepál, Sikkim. Allied to *F. pyrrhochlora*, Walker, and *F. virescens*, Westw., but differing structurally from both in its short abruptly compressed cephalic process. The Indian Museum possesses specimens from Sikkim.

To this section also belong the following species:—

*F. coccinea*, Walker, List Hom. B. M. Suppt. p. 42 (1858). Ceylon.

*F. decorata*, Westwood, Trans. Linn. Soc. xviii, p. 141, t. 12, f. 4, (1841). Java.

*F. guttifera*, Stål, Ofvers. K. V.-A., Förh. p. 448 (1859). Ceylon, Shanghai?

*F. pyrrhochlora*, Walker, Butler, P. Z. S. p. 101 (1874). Borneo.

Sec. E. *Species with pale greenish wings (subhyaline).*20. *FULGORA VIRESCENS*, Westwood.

*Fulgora (Pyrops) virescens*, Westwood, A. M. N. H. ix, p. 119 (1842).

*Fulgora (Hotina) virescens*, Westwood, Cab. Or. Ent. p. 8, t. 3, f. 5 (1848).

*Pyrops virescens*, Walker, Cat. Hom. B. M. ii, p. 209 (1851).

*Hotinus semiannulus*, Walker, l. c. Suppt. p. 42 (1858).

*Fulgora virescens*, Butler, P. Z. S. p. 102 (1874).

Cephalic process short, conical, scarcely bent upwards: entirely pale green with a minute black spot on each side of the prothorax and scutellum; the tegmina broad with the anterior margin much arched, green with numerous small rounded orange-coloured spots, outwardly edged with black; wings very pale green and semitransparent (*Westw.*). Body long with the cephalic process 19—20: exp. teg. 56—58 millims.

Reported from India, Silhat: the Indian Museum possesses a specimen from Silhat.

To this section also belongs the following species:—

*F. cultellata*, Walker, J. L. S. Zool. i, p. 143 (1857). Borneo.



Genus *ALCATHOUS*, Stål.

Trans. Ent. Soc. (3 Ser.) i, p. 577 (1863).

Head much narrower than the thorax, protuberant, frons somewhat roundly-amplified near the apex, thence distinctly narrowed upwards, tricarinate; clypeus carinate in the middle: rostrum almost reaching the apex of the abdomen: antennæ short, second joint very briefly sub-cylindrical, obliquely truncated at the apex. Thorax unicarinate in the middle, somewhat produced anteriorly in the middle, produced part truncated, posterior margin, straight: scutellum tricarinate, twice as long as the thorax. Tegmina somewhat amplified towards the apex which is obtusely obliquely rounded, longitudinal veins rarely furcate, interior simple, only third apical part furnished with remote, transverse, small veins, irregularly anastomosed: wings with more than the basal half without transverse veinlets. Feet moderate, anterior femora beneath slightly dilated, posterior tibiæ, 5—6 spinose (*Stål*). Allied to *Fulgora*.

21. *ALCATHOUS FACIALIS*, Stål.*Alcathous facialis*, Stål, Trans. Ent. Soc. (3 ser.) i, p. 577 (1863).

Livid, dorsum of abdomen and coccineous wings excepted, minutely sprinkled fuscous, here and there infuscate: tegmina clouded fuscous with small costal spots, apex of wings, broad posterior limbus and some spots near the anal area, two rows of spots on the dorsum of the abdomen and rings on the tibiæ blackish; femora fuscous, obscurely irrorated, banded palely. ♀, long, 15; exp. teg. 32 millims.

Head a little shorter than the thorax and scutellum together, produced part somewhat subabruptly narrowed and compressed before the eyes, before the middle transversely impressed and somewhat reflexed; vertex at the base more than twice as broad as the transverse eye, basal half triangular, apical part very narrow; frons flat beneath the middle, furnished with three parallel ridges, the median ridge interrupted in the middle; transverse veinlets on the tegmina are subrufescent (*Stål*).

Reported from N. India.

Genus *PYROPS*, Spinola.*A. S. E. F.* viii, p. 231 (1839); *Am. & Serv., Hist. Nat. Ins. Hém.* p. 491 (1843); *Stål, Hem. Afric.* iv, p. 133, 139 (1866).

Head produced forwards, in a long process, somewhat rounded, gradually very slightly somewhat slender, straight, obliquely truncated at the apex; the lateral part behind the eyes furnished with a subconical or triangular callus or knob; vertex transversely convex, continued up to the apex of the process; genæ rounded anteriorly: eyes small;

second joint of antennæ short, thick. Pronotum and scutellum fairly convex transversely, without ridges, the former gradually narrowed forwards, barely or very slightly sinuated at the base. Entire tegmina or the largest portion reticulated, valvate behind the clavus. Feet somewhat thick and short; first tibiæ, femora, and trochanters together equal in length, last armed with 5—7 spines (*Stål*).

## 22. PYROPS PUNCTATA, Olivier.

*Fulgora punctata*, Olivier, Enc. Méth. vi, p. 569 (1791); Stoll, Cigales, p. 34, t. 6, f. 28 (1788); Gray, Griffith's An. King, t 138, f. 2 a-c (1832).

*Flata punctata*, Germar, Thon's Archiv. ii (2), p. 47 (1830).

*Fulgora affinis*, Westwood, Trans. Linn. Soc. xviii, p. 144, t. 12, f. 6 (1841).

*Pyrops punctata*, Spinola, A. S. E. F. viii, p. 237 (1839); Walker List Hom. B. M. ii, p. 268 (1851).

Cephalic process almost as long as the body, truncated at the apex; luteous-greyish; thorax, feet, and tegmina sprinkled with black dots: abdomen above black: wings white, veins pallid. Head, cephalic process, pro- and meso-notum and tegmina pale luteous, sprinkled with black dots, varying in size: cephalic process almost as long as the body, almost straight, subcylindrical, obliquely truncated at the apex, fuscous-luteous, rough with dots, paler at the apex: the black dots on the tegmina disposed longitudinally on the veins: wings white, subopaque, a little infusate towards the apex, veins paler, except at the base: abdomen black, with the narrow margin of the segments, luteous; feet short, luteous; femora with a subapical ring; tibiæ with three black rings (*F. affinis*, Westw.). Body long with cephalic process,  $33\frac{1}{2}$ ; exp. teg. 55 millims.

Reported from China, Nepál, Silhat, Ceylon, Java, Guinea (?): the Indian Museum possesses specimens from Sikkim.

## 23. PYROPS PERPUSILLA, Walker.

*Pyrops perpusilla*, Walker, List Hom. B. M. ii, p. 269 (1851).

Body stramineous; head with its process as long as the rest of the body; abdomen luteous above: legs yellow; tegmina very pale stramineous; a few brown dots on the veins near the tip and along the hind border which is somewhat darker than the rest of the wing; a rather large dot in the disc on the fork of one of the longitudinal veins: wings colourless, veins pale yellow (*Walker*.) Body long  $8\frac{1}{2}$ ; wings, long 9 millims.

Reported from N. Bengal.

## Genus HOMALOCEPHALA, Amyot &amp; Seville.

*Omalocephala*, Spinola, A. S. E. F. viii, p. 261 (1839) : *Homalocephala*, Am. & Serv., Hist. Nat. Ins. Hém. p. 492 (1843) ; Stål, Hem. Afric. iv, pp. 133, 145 (1866).

Head broad, somewhat narrower than the thorax, produced before the eyes, round or triangular ; behind the eyes prominulous backwards in a short, thick spine : vertex at least four times broader than the eyes, flat or somewhat so : frons flat somewhat broader than the clypeus, sides parallel, very slightly amplified towards the apex ; clypeus without a median ridge : rostrum reaching the last coxæ. Thorax broadly rounded anteriorly, furnished with a fine longitudinal ridge : scutellum more than twice as long as the thorax. Tegmina with the sides parallel, obliquely obtusely rounded at the apex, very densely reticulated, reticulation in the costal area obsolete, claval vein united with the commissure at the apex of the clavus : wings entire. Feet somewhat short, simple ; first tibiæ as long as the femora, last armed with 3—4 spines (*Stål*).

## 24. HOMALOCEPHALA FESTIVA, Fabricius.

*Fulgora festiva*, Fabricius, Spec. Ins. ii, p. 315 (1781) ; Mant. Ins. ii, p. 261 (1787) ; Olivier, Enc. Méth. vi, p. 572 (1791) ; Fabr., Ent. Syst. iv. p. 5 (1794) ; Syst. Rhyng. p. 4 (1803) ; Donovan, Ins. India, Hem. t. 7, f. 2 (1800).

*Omalocephala festiva*, Spinola, A. S. E. F. viii, p. 261 (1839) ; Walker, List Hom. B. M. ii, p. 283 (1851).

*Homalocephala festiva*, Am. & Serv., Hist. Nat. Ins. Hém. p. 493 (1843).

Head above flat, fuscous ; beneath flavescent, with a black margin : thorax fuscous, immaculate : tegmina fuscous, exterior margin virescent, which colour, however, does not reach the apex of the wing : there are five black dots along this margin of which the four posterior end inwards in a fulvous dot : wings sanguineous, fuscous at the apex (*Fabricius*).

Head above flat, obscure ; beneath, yellowish, border black : thorax obscure immaculate : tegmina obscure with the costal margin greenish which does not extend to the apex, on this part are five black spots of which the four posterior are bounded internally by a tawny spot : wings sanguineous with the apex obscure (*Olivier*). Donovan states that the tegmina have a green margin on which there are a few black spots semicircled with orange. Long, 17 millims.

The Indian Museum possesses a very mutilated specimen.

## Genus LIMOIS, Stål.

Stettin Ent. Zeit. xxiv, p. 230 (1863) : Hem. Afric. iv, p. 134 (1866).

Head narrower than the thorax, slightly protuberant upwards ; frons longitudinally convex, abruptly dilated on both sides at the apex,



much narrowed upwards, bicarinate lengthways, lateral margins reflexed beneath the middle; vertex transverse; clypeus carinate in the middle, lateral margins obtuse, obtusely carinate; thorax twice as broad as the head, somewhat sloped forwards, broadly truncate posteriorly, obsoletely carinate in the middle: tegmina somewhat amplified towards the apex, which is obliquely obtusely rounded, furnished behind the middle with remote small transverse veins: wings sinuate in the middle, posteriorly, much shorter than the tegmina: feet moderate, simple; posterior tibiæ 5-spinose (*Stål*). Differs from *Aphana* in the structure of the head and the short wings.

## 25. LIMOIS WESTWOODII, Hope.

*Lystra westwoodii*, Parry, Hope, Trans. Linn. Soc. xix, p. 133, t. 12, f. 3 (1845); Walker, List Hom. B. M. ii, p. 286 (1851).

*Limois westwoodii*, Stål, Stettin Ent. Zeit. xxiv, p. 231 (1863).

Fuscous yellow, cephalic process concolorous, recurved between the eyes; frons almost triangular, elongate: basal half of tegmina fuscous yellow, sprinkled with fuscous spots, varying in size: wings at the base sanguineous and margined by a narrow black line and with three black spots, remainder immaculate, hyaline: body beneath black. (*Hope*.) Body long,  $12\frac{1}{2}$ ; exp. teg. 48 millims.

Reported from Silhat: the Indian museum possesses a specimen from Calcutta, expanse of tegmina under 40 millims.

## Genus APHANA, Guérin, Stål.

*Aphæna*, Guérin, Voy. Bélanger, Ind. Orien. p. 451 (1834); Spin., A. S. E. F. viii, p. 240 (1839): *Aphana*, Burm., Handb. Ent. ii (i) p. 166 (1835); Amyot & Serville, Hist. Nat. Ins. Hém. p. 496 (1843); Stål, Stettin, Ent. Zeit. xxiv, p. 231 (1863); Hem. Afric. iv, p. 134 (1866).

Head not protuberant; frons slightly narrowed upwards or with the sides parallel, lateral margins more or less distinctly broadly bisinuate with two ridges running through them, diverging upwards from the apex, terminating on both sides the median area: thorax with a ridge very often much elevated: first femora not amplified above at the apex; last tibiæ usually 5-spinose, unarmed above at the base (*Stål*).

## 26. APHANA FARINOSA, Fabricius.

*Lystra farinosa*, Fabricius, Syst. Rhyng. p. 57 (1803): Germar, Thon's Archiv, ii (fasc. 2) p. 52 (1830).

*Aphana farinosa*, Spinola, A. S. E. F. viii, p. 244 (1839); Walker, List Hom. B. M. ii, p. 274 (1851).

*Aphana scutellaris*, White, A. M. N. H. xvii, p. 330 (1846).

*Aphæna scutellaris*, Westwood, Cab. Or. Ent., p. 73, t. 36, f. 3 (1848); Walker, List Hom. B. M. ii, p. 277 (1851); J. L. S. Zool. i, p. 143 (1857); var. l. c. x, p. 96 (1867).

*Aphæna saundersii*, Walker, List Hom. B. M. ii p. 277 (1851); J. L. S. Zool. i. p. 84 (1856); l. c. p. 143 (1857).

*Aphana farinosa*, Burm., Handb. Ent. ii (2), p. 166 (1835); Stål, Ofvers. K. V.-A. Förh., p. 485 (1862); Stettin Ent. Zeit., xxiv, p. 232 (1863).

Fuscous; tegmina yellow at the apex; base of the wings and the abdomen, red, the former spotted hyaline (*Fabr.*). Head, pronotum, and border of the tegmina, reddish-brown, the under half of the same black, apex golden yellow, powdered white: wings with a red ground with small white spots; tip brown: feet, black (*Burm.*). Larger than *A. atomaria*, Fabr. greenish-brown; occiput excavated and marked with two whitish powdery spots between the eyes; the pronotum with an elevated ridge down the middle, the scutellum powdered with white, the metathorax blackish; the margins of the abdominal segments luteous-green, the base powdered with white; the basal half of the tegmina ferruginous, the disc powdered with white, and with an irregular black fascia in the middle and some blackish spots near the hind margin, the apical portion horn-coloured, varied with buff, hind-wings orange red, spotted with white, the base black, the apical portion horn-coloured, and the anal angle buff; body beneath, and legs, pitchy (*Westwood*). Body long, 22; exp. teg.  $52\frac{1}{2}$ —66 millims.

Reported from Borneo, Java, Sumatra, India (*Spin.*): the Indian Museum has a much abraded specimen from Sinkip Island. The type described by White was from Borneo and varies in the green colour of the basal portion of the costa and the base of the tegmina. Westwood's specimen was from Java and the Indian specimen agrees best with his description.

## 27. APHANA ATOMARIA, Weber.

*Cicada atomaria*, Weber, Obs. Ent. p. 113 (1801).

*Lystra atomaria*, Fabricius, Syst. Rhyng., p. 57 (1803); Germar in Thon's Archiv. ii (fasc. 2), p. 52 (1830).

*Aphæna nigro-punctata*, Guérin, Voy. la Coquille, Zool. ii, (2), p. 185 (1830); Spin., A. S. E. F. (1 sér.) viii, p. 248 (1839); Am. & Serv., Hist. Nat. Ins. Hém. p. 497, (1843); Walker, List. Hom. B. M. ii, p. 274 (1851).

*Aphæna atomaria*, Spin., l. c. p. 248 (1839); Walker, l. c. p. 277 (1851); J. L. S. Zool. x, p. 96 (1867).

*Aphana atomaria*, Burm., Handb. Ent. ii (i) p. 167 (1835); Stål, Stettin Ent. Zeit. xxiv, p. 232 (1863); Hem. Fabr. ii, p. 87 (1869).

Fuscous, vertex and pronotum brick-colour: tegmina ferruginous, spotted black, abdomen above and wings sanguineous, the latter black at the apex and spotted black-hyaline (*Fabr.*). Head and pronotum

ochreous; mesonotum reddish-brown: tegmina of a red brown in the basal two-thirds with two large black spots on the external margin, another towards the end of the second third, in the middle; two other smaller black dots, one at the base and the other towards the end of the first third near the internal margin, and other smaller black dots sprinkled here and there: the apical third of the tegmina sordid yellowish or dull brown: wings bright red with the apex black, sprinkled with bluish spots or patches, the red disc also has four white patches, of which one is very small, with some dozen round black dots strewn about behind them: abdomen red above: body and feet, beneath, reddish-brown (*Am. & Serv.*) Long, 17; exp. teg. 46 millims.

Reported from Sumatra, Java, N. India: the Indian Museum possesses one abraded specimen exactly agreeing with the above description, locality unknown, and another from Marri (Panjab). There is a series from Sikkim agreeing in most respects except that the base of the wings is ochreous not sanguineous.

## 28. APHANA PULCHELLA, Guérin.

*Aphana pulchella*, Guérin, Voy. la Coquille, Zool. ii (2), p. 189 (1830); Spinola, A. S. E. F. viii, p. 294 (1835); Walker, List Hom. B. M., ii, p. 274 (1851); Stål, Ofvers. K. V.-A., Förh. p. 485 (1862); Java.

*Aphana confucius*, White, A. M. N. H. xviii, p. 24 (1846): China.

*Aphana confucius*, Walker, l. c. p. 280 (1851): China.

*Aphana io*, Walker, List Hom. B. M. ii, p. 279 (1851): N. India.

*Aphana nigro-irrorata*, Stål, Ofvers. K. V.-A. Förh. p. 244 (1854): China.

*Aphana nigro-irrorata*, Stål, Freg. Eng. Resa, Ins., p. 270 (1859): Hong-Kong.

*Aphana pulchella*, Stål, Stettin Ent. Zeit., xxiv, p. 232 (1863).

Smaller than *A. atomaria*, Fabr., from which it differs in not having the head and thorax yellow, by the tegmina spotted with irregular black dots and the feet yellowish, annulated blackish. Head pro- and meso-notum yellowish punctured grey; metanotum and abdomen vermillion, two small black spots on the former and weak black bands on the three first segments of the abdomen, which also show traces of being covered with a white cottony substance: head and thorax beneath of a fairly deep yellowish-brown with a white patch between the intermediate and posterior coxæ: abdomen beneath ochreous yellow, punctured black, the lateral margin of each segment with a black excavation, filled with a white powdery substance; feet brown, annulated yellow. Tegmina of a somewhat faded saffron-yellow, semitransparent, more yellow towards the apex, covered with numerous small black dots, a few larger; towards the tip and the interior margin a whitish quadrate spot, followed at the posterior and external angle by a brown patch confluent with the small black dots of the apex: wings vermillion, carmine



towards the base and a little orange in the middle and on the side of the anterior border: tip with a large black patch, adorned with small blue spots; posterior margin slightly infusate and disc with 16—17 small, nearly equal, black spots and four small white spots placed in the orange portion (*Guérin*). Long, 15: exp. teg. 37 millims.

The Indian form (*A. io*, Walker) is thus described:—

Body yellowish-brown; head and mesonotum punctured black, carinate; rostrum brown, as long as the body; metanotum, red; abdomen bright red; beneath, spotted black with a black stripe along each side and a brown posterior margin on each segment: legs black, femora and tibiæ flavo-annulate, posterior tibiæ spinose: tegmina yellowish-brown with numerous black marks which are confluent and form a black spot at the tip of the hind border; this spot has a yellowish-white spot adjoining; wings luteous, red at the base and along the inner border, with about 12 black and 4 white spots, brown along the hind border, terminating in a very large black spot which has a blue disc (*Walker*). Body long,  $16\frac{1}{2}$ ; exp. teg. 46 millims.

Reported from China, Java, India: the Indian Museum possesses specimens from Sikkim and the Andamans.

## 29. APHANA VARIEGATA, Guérin.

*Aphæna variegata*, Guérin, Voy. Bélanger Ind. Orien. Zool. p. 455 (1834); Icon. Règne Anim., t. 58, f. 3 (1830-34); Spin., A. S. E. F. viii, p. 247 (1839); Walker, List Hom. B. M. ii, p. 278 (1851).

*Penthicus variegatus*, Blanchard, Hist. Nat. Ins. iii, p. 171, Hém. t. 12, f. 4 (1840-41).

*Aphæna basirufa*, Walker, List Hom. B. M. ii, p. 278 (1851); J. L. S. Zool. i, p. 143 (1857).

*Aphana variegata*, Am. & Serv., Hist. Nat. Ins. Hém. p. 497, t. 9, f. 1 (1843); Stål, Stettin Ent. Zeit, xxiv, p. 232 (1863).

Head flat in front, with two slightly elevated ridges: pronotum transverse, anterior border lobed and a little advanced, carinate in the middle, with a hollow on each side behind the median lobe, and a little emarginate posteriorly: mesonotum triangular, sides almost equal, pointed behind, tricarinate in the middle, one ridge longitudinal, and two lateral, curved: metanotum and abdomen bright red, separated by a white, farinose, transverse band; the head, pro-, and meso-notum brown, touching on deep olive-green. Tegmina brunneous, a little reddish at the base, more greenish at the tip with black patches and round black dots which increase in size towards the apex; two square yellowish patches at the middle third, one on the anterior, the other on the interior margin: wings much broader, a little sinuated on the posterior margin; the base up to one-third of their length bright red with three

black spots and an obscure patch ; middle third orange yellow ground with red, above 2-3 small white dots and below a small black spot : the apex is black with more or less numerous or confluent small blue dots ; posterior margin from this black portion to the internal angle is broadly bordered brown. Body beneath concolorous with the thorax, feet more blackish (*Guérin*). Long, 20 ; exp. teg. 55 millims.

Reported from Cochin-China, Philippines, Silhat : the Indian Museum possesses specimens from Sikkim.

### 30. *APHANA CAJA*, Walker.

*Aphæna caja*, Walker, List Hom. B. M. ii, p. 278 (1851).

*Aphana caja*, Stål, Stettin Ent. Zeit. xxiv, p. 235 (1863).

Fuscous-ochraceous ; thorax palely granulate towards the sides ; tegmina fawn-colour or palely olivaceous, clouded with black-fuscous and sprinkled with minute black-fuscous spots, further, behind the middle, adorned with a pallid subquadrate spot at the costal and commissural margins : wings croceous, sanguineous at the base, a small oblique, basal streak and 5-7 spots in anal half, black-fuscous ; 3-4 small white discoidal spots in the anterior area ; posterior limbus narrowly fuscous ; apical part black-fuscous, sprinkled with glaucous-mouldy spots ; abdomen sanguineous, dorsum with a double row of black spots, beneath fuscous-sanguineous : feet spotted olivaceous. ♀, long 21 ; exp. teg. 62 millims.

Nearly allied to *A. variegata*, *Guérin*, but larger, spots on the tegmina larger, wings sanguineous only at the base, posterior fuscous limbus narrower and especially with the vertex shorter, nearly thrice broader than long, more obtusely rounded, transverse basal keel straight, anterior margin less deeply sinuate in the middle : frons subequal at the base and the apex, not distinctly narrower at the base, anterior produced part of thorax more obtusely rounded. Frons somewhat longer than broad, lateral margins slightly broadly bisinuate, with two obtuse ridges diverging upwards and with an obsolete longitudinal ridge towards the base, the median area at the base very broadly rounded : thorax marked before the middle with two obsolete pallid spots (*Stål*).

Reported from Silhat.

### 31. *APHANA DIMIDIATA*, Hope.

*Lystra dimidiata*, Hope, Trans. Linn. Soc. xix, p. 133, t. 12, f. 4 (1845) ; Walker, List Hom. B. M. ii, p. 286 (1851).

*Aphana dimidiata*, Stål, Stettin Ent. Zeit. xxiv, p. 232 (1863).

Fuscous ; head, thorax, and feet concolorous : basal half of tegmina virescent, sprinkled with numerous minute dull black spots, apices sub-orange-hyaline marked with cretaceous spots : basal half of wings greenish with the posterior part whitish, spotted black, apices fuscous, irrorated with virescent spots (*Hope*). Long  $14\frac{1}{2}$  : exp. teg. 46 millims.

Reported from Silhat.

### 32. *APHANA NICOBARICA*, Stål.

*Aphana nicobarica*, Stål, Berlin Ent. Zeitschr. xiii, p. 241 (1869).

Sordid olivaceous-green : scutellum, pectus, abdomen, and feet black-fuscous : tegmina before the middle æruginous, sprinkled with black ; behind the middle, ochraceous, marked with a band and mouldy spots ; apical limbus, black ; wings, black, a very large basal spot cærulean-virescent. Long 19 ; exp. teg. 55 millims, ♀.

Size of *A. farinosa*, Burm., from which it differs in the head produced anteriorly, seen from above equal in length and breadth between the eyes, roundly-angulated ; frons longer, furnished with a recurved process. Frons rugulose, tumescent at the base and with a median process short, compressed, recurved, obsoletely tricarinate, the ridges diverging upwards, the median ridge disappearing below the middle : vertex narrowed forwards, obsoletely carinate in the middle ; lateral margins dilated, elevated : thorax furnished with a raised, acute ridge, running through it, strongly bi-impressed on the disc, scutellum tricarinate. The æruginous half of the tegmina covered with minute and often confluent black dots, closer at the apex ; apical half ochraceous with the apical limbus black ; the spots and an anterior band clothed with a white powdery substance : wings black with a large basal patch extended a little beyond the middle, cærulean-virescent. Apical margins of the dorsal segments of the abdomen, green (*Stål*).

Reported from the Nicobars.

### 33. *APHANA* (?) *DIVES*, Walker.

*Aphæna dives*, Walker, List Hom. B. M. ii, p. 280 (1851).

Body dark ferruginous ; disc of the vertex rather concave, borders slightly ridged, fore margin slightly inclined upwards : rostrum extending far beyond the posterior coxæ, dark brown : mesonotum with a slight longitudinal furrow, fore-border very undulating ; a black band along the fore-border of the scutellum ; metanotum black : abdomen obconical, larger than the thorax, black above, thickly covered with white down, red beneath : legs black, sulcated, femora brown, posterior tibiæ spinose : tegmina green, adorned between the veins with orange streaks which are interrupted by very numerous brown dots, the latter are



sometimes confluent; a tawny slightly curved band separates this part from the reticulated tips which are brown with tawny veins: wings green, with numerous brown spots, gray mingled with white towards the tips, white along the inner border (*Walker*). Long,  $14\frac{1}{2}$ : exp. teg. 42 millims.

Reported from Malabar.

### 34. *APHANA* (?) *ALBIFLOS*, Walker.

*Aphæna albiflos*, Walker, List Hom. B. M. ii, p. 280 (1851).

Body above, green; beneath, bright-red; vertex tawny, indistinctly carinate along the border; face slightly carinate; rostrum nearly as long as the body, tip black; a concavity corresponding to the eye on each side of the fore-border of the pronotum of which the anterior portion of the lateral margins is black, posterior margin, tawny; longitudinal ridge almost obsolete: abdomen obconical, much longer than the thorax, thickly covered with white down: legs ferruginous, sulcated; femora, red; posterior tibiæ slightly spinose: tegmina black, adorned with numerous little green marks; reticulated part, ferruginous; wings brown, adorned with bluish-green spots, white at the tips and along the posterior margin (*Walker*). Body long,  $16\frac{1}{2}$ ; exp. teg. 55 millims.

Reported from Malabar.

### Genus *LYCORMA*, Stål.

Stettin, Ent. Zeit. xxiv, p. 232 (1863): part *Aphæna*, Guérin.

Head somewhat protuberant, protuberance very short, reflexed: frons, distinctly upwards and at the base more narrowly, furnished with two parallel obtuse ridges, sometimes obliterated beneath the middle; vertex truncated at the base, last angles not produced: thorax finely carinate in the middle: first femora not amplified at the apex above: last tibiæ armed with 4-5 spines; unarmed at the base, above (*Stål*).

### 35. *LYCORMA IMPERIALIS*, White.

*Aphana imperialis*, White, A. M. N. H. xvii, p. 330 (1846).

*Aphæna imperialis*, Westwood, Cab. Or. Ent. p. 74, t. 36, f. 4 (1848); Walker, List Hom. B. M. ii, p. 282 (1851).

*Aphæna placabilis*, Walker, l. c. Suppt. p. 46 (1858).

*Lycorma imperialis*, Stål, Ofvers. K. V.-A. Förh. p. 485 (1862); Stettin Ent. Zeit. xxiv, p. 232 (1863).

Tegmina olive-green, the basal portion with numerous black spots, most of which are traversed by green veins; the tip black, beautifully reticulated with olive-green: wings, at the base, purplish madder with

11—12 large black spots, the purplish part reticulated with whitish; the end brownish-black; a bluish-green band-like mark across the middle of the wing, not nearly reaching the hind margin, the three nerves traversing it are black; tegmina and wings beneath almost same as above: head and thorax above greenish; prothorax finely, transversely striated, a line, down the middle, shining; abdomen black, margins yellow, segments slightly powdered with white, vulvar scales red; legs brown, tibiae of hind legs tridentate on the outside (*White*). Exp. teg. 61 millims.

Reported from Silhat: the Indian Museum possesses specimens from Sikkim. Red: metanotum black: abdomen with a red transverse line at the base; tip red beneath: tegmina with black spots along the costa and with some more or less interrupted and irregular black bands; more than one-third of the apical part black with very numerous and regular black veins and veinlets: wings black, basal half red with several black spots; a white middle band, not extending to the hind border (*A. placabilis*, Walker). Body long  $16\frac{1}{2}$ ; teg.  $54\frac{1}{2}$  millims. This is the reddish-brown variety.

### 36. *LYCORMA PUNICEA*, Hope.

*Lystra punicea*, Hope Trans. Linn. Soc. xix, p. 133, t. 12. f. 5 (1843); Walker, List Hom. B. M. ii, p. 286 (1851).

*Aphaena delectabilis*, Walker, l. c. Suppt. p. 44 (1858).

*Lycorma punicea*, Stål, Stettin Ent. Zeit. xxiv, p. 232 (1863).

Reddish purple, head and thorax paler; basal half of tegmina tinted rosy and sprinkled with numerous black spots; apex hyaline fuscous-puniceous with a pellucid mark in the middle of the disc: wings puniceous at the base, marked by black spots, whitish in the middle and fuscous-hyaline, at the apex (*Hope*). Long  $12\frac{1}{2}$ ; exp. teg. 48 millims.

Ferruginous brown, black beneath: antennae bright red; pronotum dull green with some very minute, testaceous, brown-bordered spots: abdomen black: hind borders of the segments luteous on each side, beneath: legs black: tegmina black, whitish green with black spots for about one-third from the base, outline of the green part much excavated with some streaks same hue near it; veins green: wings bright red with black spots, apical part blackish brown, divided from the red part by a bright greenish blue band which does not extend to the hind margin. (*A. delectabilis*, Walker). Body long,  $12\frac{1}{2}$ ; exp. teg. 42 millims.

Reported from N. China, Shanghai, India, Silhat. The Indian Museum possesses a mutilated specimen from the Dikrang valley, Assam.

37. *LYCORMA IOLE*, Stål.

*Lycorma iole*, Stål, Stettin Ent. Zeit. xxiv, p. 234 (1863).

Blackish: the lateral posterior blotch on the vertex, thorax, lateral margins of scutellum, and the tegmina more or less purely green-olivaceous, the tegmina with 23-28 largish black spots, barely third apical part black, green-veined: wings coccineous with 8-10 black spots, black-fuscous behind the middle and there with a shortened band, virescent or cærulescent; anal valvules in ♀ sanguineous (*Stål*). ♀ long, 17; exp. teg. 52 millims.

Reported from India: closely allied to *L. delicatula*, White, larger, cephalic process less prominulous, and the spots on the tegmina and wings larger.

38. *LYCORMA DELICATULA*, White.

*Aphana delicatula*, White, A. M. N. H. xv, p. 37 (1845).

*Aphæna delicatula*, Walker, List. Hem. B. M. ii, p. 282 (1851).

*Aphæna operosa*, Walker, l. c. Suppt. p. 46 (1858).

*Lycorma delicatula*, Stål, Ofvers. K. V.-A. Förh. p. 485 (1852); Stettin Ent. Zeit. xxiv, p. 232 (1863).

Tegmina very pale greenish brown, basal part with many black spots (at least twenty) of which six on the anterior margin: the end darker brown, beautifully reticulated with pale greenish brown: wings at the base, vermilion red with largish black spots, irregular on either side (at least seven), tip widely black; a large acutely triangular sea-green mark on the fore-edge between the red and black parts: antennæ orange: head and thorax above of a pale brownish colour with a sort of bloom over them: body and legs blackish brown with a slight bloom (*White*). Exp. teg. 41 millims.

Reported from Nankin, Canton, China: very doubtfully from Sib-ságar (Assam). The cephalic process in this species is a little more elevated than in *L. imperialis*, White, to which it otherwise bears a strong resemblance: the black spots on the wings and tegmina also are smaller, the tegmina are palely olivaceous or whitish fawn-colour: the median band on the wings varies, as in all the others of this group, from whitish to cærulescent or virescent (*Stål*).

## Genus EUPHRIA, Stål.

Stettin Ent. Zeit. xxiv, p. 232 (1863); part of *Aphæna*, Guérin.

Head furnished with a cephalic protuberance, very slender, acute, reflexed or erect; frons distinctly narrowed upwards, abruptly narrower at the base furnished with 2-3 ridges, a little elevated, parallel: vertex



very broadly sinuated at the base: thorax barely carinate in the middle: first femora slightly amplified at the apex above; last tibiæ 4-spinose; unarmed above at the base (*Stål*).

### 39. EUPHRIA AURANTIA, Hope.

*Aphana aurantia*, Hope, Trans. Linn. Soc. xviii, p. 443, t. 31, f. 2 (1841).

*Euphria aurantia*, Stål, Stettin Ent. Zeit. xxiv, p. 232 (1863).

Entire body above orange; tegmina sprinkled with barely visible yellow spots, posteriorly spotted black; a few minute spots on the internal margin and a very narrow border on the posterior margin, black: head excavated above, margins elevated; frons produced above the pronotum in a small, tapering, recurved horn: abdomen, at the base, covered with a white powdery substance; body beneath concolorous, a little more obscure (*Hope*). Long 19; exp. teg. 63 millims.

Reported from Assam; the Indian Museum possesses a specimen from Sikkim.

Fresh specimens have the tegmina green instead of orange, sprinkled with whitish powdery spots or patches, more distinct beneath: wings orange, body and abdomen orange yellow, in one specimen inclined to brown; feet (except posterior femora) in some greenish, in others concolorous with the abdomen, recurved horn in some green, in others orange. Also the apices of the tegmina are sometimes faded yellow more or less. A long series should supply the links. The Indian Museum has several specimens from Darjiling.

### 40. EUPHRIA SUBMACULATA, Westwood.

*Aphæna submaculata*, Westwood, Duncan's Nat. Lib. i. p. 284 t. 24, f. 1 (1840); Walker, List Hom. B. M. ii, p. 275 (1851).

*Aphana resima*, Stål, Ofvers. K. V.-A., Förh. p. 190 (1855).

*Euphria submaculata*, Stål, Stettin Ent. Zeit. xxiv, p. 232 (1863).

Sordid yellow-testaceous; frons with a cephalic protuberance or horn, twice as long as the vertex, channelled above, recurved: lateral margins of thorax narrowly black: scutellum obsoletely tricarinate: tegmina rufous-testaceous above densely spotted whitish-mouldy, costal spots subglaucous: wings nigro-fuscous, yellow-cinnamon beyond the middle, especially before the middle spotted whitish mouldy: abdomen above whitish-mouldy (*E. resima*, Stål). Body long 21; exp. teg. 71 millims.

Reported from India: the Indian Museum possesses specimens from Sikkim.

### 41. EUPHRIA LECTISSIMA, Walker.

*Aphæna lectissima*, Walker, List. Hom. B. M. Suppt. p. 45 (1858).

Grass-green: head with a short, acute, almost vertical horn; sides of the vertex carinate; frons and face flat, the latter with a slight ridge:

abdomen above testaceous : tegmina livid, red beneath, except towards the apex, adorned with many green, white-dotted, spots ; border green, adorned with dots of white tomentum along the costa, and with black dots elsewhere, except towards the base of the inferior border where the dots are luteous : wings crimson for more than half the length from the base (*Walker*). Body long, 21 : exp. teg. 33 millims.

Reported from N. India : the Indian Museum possesses a specimen from Sikkim. Closely allied to *E. amabilis*, Hope, from which it differs in the absence of the three fulvous spots on the pronotum and of the blackish lines on the mesonotum and posterior margins of the abdominal dorsal segments, and in the spots on the tegmina, which are small and circular, nowhere linear and transverse. Stål (*Ofvers. K. V.-A. Förh.* p. 486, 1862) unites the two species.

#### 42. EUPHRIA AMABILIS, Hope.

*Aphana amabilis*, Hope, *Trans. Linn. Soc.* xix, p. 132, t. 12, f. 1 (1845) ; *Walker, List. Hom. B. M.* ii, p. 274 (1851).

*Euphria amabilis*, Stål, *Stettin Ent. Zeit.* xxiv, p. 232 (1863).

Body above orange ; head green, furnished with an erect, acute, slender horn : prothorax green, marked by three fulvous spots : tegmina cretaceous sprinkled with numerous oval spots ; wings coccineous, palely virescent at the apex : body beneath green ; feet concolorous ; pectus sprinkled over with a whitish down. The spots which above appear to be white and green intermixed are beneath entirely green (*Hope*). Long 25 : exp. teg. 69 millims.

Reported from Silhat.

#### 43. EUPHRIA AURORA, Hope.

*Aphana aurora*, Hope, *Trans. Linn. Soc.* xix, p. 133, t. 12, f. 2 (1845) : *Walker, List. Hom. B. M.* ii, p. 275 (1851).

*Euphria aurora*, Stål, *Stettin Ent. Zeit.* xxiv, p. 232 (1863).

Allied to *E. aurantia*, but smaller ; almost the whole body orange : tegmina externally barely virescent, internally orange and sprinkled with very minute whitish spots : body beneath concolorous : wings with cretaceous spots ; last tibiæ externally spinose (*Hope*). Body long, 19 ; exp. teg. 61 millims.

Reported from Silhat, Philippines.

#### 44. EUPHRIA (P) WALKERI, n. sp.

*Aphæna dives*, var. (P), *Walker, List. Hom. B. M.* ii, p. 281 (1851).

Body yellowish brown, red beneath : vertex slightly ridged and furrowed : frons rather prominent, furnished with a slender, black, linear furrowed horn which is inclined backward nearly to the posterior margin

of the shield: rostrum ferruginous, tip darker, extending nearly to the tip of the abdomen: an excavation partly inclosing the eye on each side lateral margins of pronotum and most of metanotum, black: abdomen a little longer than the thorax, nearly elliptical, red, with a black band across each segment above: legs black, furrowed, femora red, posterior tibiæ spinose: tegmina not much longer than the wings, apex obtuse, pale dingy yellow with very numerous brown marks, reticulated part, yellowish-brown: wings brown with many almost colourless spots which are partly confluent, posterior margin almost colourless, tip pale brown (*Walker*). Body long  $14\frac{1}{3}$ ; exp. teg. 4.2 millims.

Reported from India.

#### Genus PHORONIS, Stål.

Stettin Ent. Zeit. xxiv, p. 233 (1863).

Head not protuberant but emitting from the base of the frons a very long, very slender, mobile, reflexed process [which in dried specimens is very easily detached]; frons a little narrower above the middle than beneath the middle, abruptly narrowed at the base, furnished with two obtuse, parallel ridges (often obliterated), lateral margins slightly sinuate beneath the middle; vertex truncated at the base: thorax hardly carinate in the middle, first pair of femora distinctly amplified above at the apex: last pair of tibiæ 4-spinose, furnished above at the base with a tubercle (*Stål*).

#### 45. PHORONIS NIGRO-MACULATA, Guérin.

*Aphæna nigro-maculata*, Guérin, Icon. Règne An. t. 90, f. 6 (1830-34); Voy. Bélanger Ind. Orient. Zool. p. 457 (1834); Spinola, A. S. E. F. (1 sér.) viii, p. 243 (1839); Walker, List. Hom. B. M. ii, p. 273 (1851).

*Fulgora (Aphæna) nigro-maculata*, G. R. Gray, Griffith's ed. An. King. Ins. ii, p. 260 t. 90, f. 6; t. 138, f. 1 a-c. (1832).

*Aphana nigro-maculata*, Westwood, Trans. Linn. Soc. xviii, p. 149 (1841).

*Phoronis nigro-maculata*, Stål, Stettin Ent. Zeit. xxiv, p. 233 (1863).

Head and thorax brown; horn black, short, flexible; tegmina brown with some small scattered black spots, exterior margin with a broad black border: wings with basal half silvery grey, spotted with black; other half, black, with the interior margin brownish black; body silvery grey, with transverse narrow bands of black (*Gray*). Head subferruginous, brown; frons with a cylindrical horn recurved backwards; thorax somewhat greenish brown: tegmina obscurely blue, apex finely reticulated with black, punctured with black on the anterior margin with five dots obliquely arranged at the base: wings blue, spotted with black, posteriorly brown, black at the apex: abdomen black, streaked



with white: body below and femora ruddy: coxæ brown (*Guérin*). Long 20; broad 55 millims.

Reported from China, Cochin-China: the Indian Museum possesses a specimen from the Andaman islands with the cephalic process absent.

#### 46. PHORONIS PAULINIA, Signoret.

*Aphaena paulinia*, Signoret, A. S. E. F. (4 sér.) ii, p. 123; t. 1, f. 6, (1862).

Brick-red with the dorsum, femora, tips of tegmina, tip of the wings and several spots on them of a blackish-brown; on the anterior margin of the tegmina several black spots and a slight filiform, recurved cephalic process. Head broader than long, vertex square, a little transverse, with a transverse ridge and a fovea on each side of the eyes: frons convex, without a ridge on the anterior margin, a black filiform appendage, with a longitudinal groove, reaching almost the end of the mesonotum: rostrum of a reddish-brown, reaching the end of the abdomen, the third joint, the longest: pronotum almost five times broader than long, posterior margin concave, anterior convex with a median emargination which gives it a bilobed appearance, presenting on each side, beneath the eyes, a strong emargination: lateral margins convex and black, a slight ridge on the disc: mesonotum weakly tricarinate, and exhibiting towards its extremity two small brown dots. Tegmina with a broad apical band formed of a network of yellow veinlets on a brown ground; on the anterior margin are numbers of black dots, the claval vein near the fold of the tegmen with 3-5 black dots: wings transparent in the middle, slightly bluish and exhibiting there about a dozen more or less regular brownish spots; tip brownish; the border, also the folded part near the abdomen, slightly infusate: abdomen red beneath, black above, with the end of the segments and the lateral margins, red; each segment, especially those of the extremity, covered with a thick farinose substance: feet with the tibiæ red and the femora black, the posterior with three strong spines on the external side (*Sign.*) Body long, 16; exp. teg. 50 millims.

Reported from Cochin-China; the Indian Museum has a specimen (with the filiform cephalic process wanting) from Tenasserim. Stål unites this with *P. nigro-maculata*, *Guérin*, but though structurally the same, the coloration of the tegmina leaves no doubt as to specific identity.

#### Genus GEBENNA, Stål.

Trans. Ent. Soc. (3 sér.) i, p. 582 (1863); Hem. Afric. iv, p. 135 (1866).

Head broadish, narrower than the thorax, not protuberant; vertex transverse, anterior margin straight, posterior margin broadly sinuate; frons subquadrate, somewhat amplified on both sides at the clypeus, median area amplified upwards, broadly subtruncate at the apex, prominulous before the apical margin of the vertex, not reflexed; clypeus

ecarinate : second joint of antennæ transverse, produced upwards from the insertion. Thorax unicarinate in the middle, roundly produced at the apex behind the vertex : scutellum about half longer than the thorax. Tegmina barely amplified towards the apex, rounded at the apex, costal margin straight, longitudinal veins rarely furcate, small transverse veins remotely scattered throughout the entire tegmina : wings remotely transversely veined behind the middle. Feet simple, last tibiæ 4-spinose with their base neither spinose nor tuberculated (*Stål*). Allied to *Aphana*.

#### 47. GEBENNA SYLVIA, Stål.

*Gebenna Sylvia*, Stål, Trans. Ent. Soc. (3 sér.) i, p. 582 (1863).

Palely grey-flavescent ; frons, vertex and disc of thorax and scutellum minutely irrorated black ; thorax and scutellum on both sides sprinkled with small black spots : tegmina weakly rufescent-ferruginous from the base beyond the middle, remotely sprinkled black, costal limbus palely olivaceous-virescent ; apical part vitreous, sprinkled and spotted fuscous ; wings vitreous, palely virescent towards the base, adorned with three irregular, large, subconfluent, black-fuscous spots, before the middle : dorsum of abdomen, black ; segments margined olivaceous at the apex ; abdomen adorned with four longitudinal rows of irregular grey-flavescent spots ; ventral segments on both sides, spotted black, interruptedly banded black at the base : feet with numerous black bands (*Stål*). ♀, long, 13 ; exp. teg. 39 millims.

Reported from India. Vertex almost thrice as broad as the transverse eye, margins somewhat elevated : frons remotely and finely rugulose, slightly narrowed upwards : thorax less distinctly rugulose : scutellum finely rugulose on the disc.

#### Genus POLYDICTYA, Guérin.

Icon. Règne Anim. Texte Ins. p. 359 (1830-34) ; Stål, Hem. Afric. iv. p. 135 (1866).

Vertex about four times as broad as the eyes : entire tegmina densely or very densely reticulated : anterior tibiæ sometimes somewhat dilated : frons obtusely rounded at the base, amplified at the apex and distinctly broader than the clypeus, tegmina thrice or more than thrice longer than broad (*Stål*).

#### 48. POLYDICTYA BASALIS, Guérin.

*Polydictya basalis*, Guérin, Icon. Règne Anim. Texte, Ins. p. 359 (1830-34) ; Walker, List. Hom. B. M. ii, p. 289 (1851) ; J. L. S. Zool. x, p. 98 (1867).

*Aphæna uniformis*, Walker, J. L. S. Zool. i, p. 144 (1857).

*Eurybrachys basalis*, Hope, Trans. Linn. Soc. xix, p. 134, t. 12, f. 6 (1845) ; Stål, Ofvers. K. V.-A. Förh. p. 500 (1862).

Fuscous yellow : head flavescent : thorax brunneous ; abdomen dull red ; tegmina fuscous, reticulated yellow ; wings at the base with a cærulean incurved line forwards, posteriorly subroseous ; remainder blackish (*Hope*). Body long, 21 ; exp. teg. 56 millims.

Reported from Sumatra, Silhat. There are at least two apparently undescribed species of this genus in the Indian Museum : one with a double incurved cærulean line at the base of the wings, abdomen vermillion with the dorsal segment more or less banded black, (body long, 16 : exp. teg. 46 millims), from the Andamans ; and one with the base of the wings red and base of the tegmina above and below with a bluish tinge, (body long, 19 : exp. teg. 53 millims), from Sikkim : but a series is desirable before describing them further.

#### 49. POLYDICTYA (?) TRICOLOR, Westwood.

*Lystra tricolor*, Westwood, Arc. Ent. ii, p. 35, t. 37, f. 4 (1845).

*Polydictya tricolor*, Walker, List. Hom. B. M. ii, p. 290 (1851).

Sanguineous, very glabrous ; anterior lobe of pronotum and mesonotum anteriorly black, basal half of tegmina (the livid base itself excepted) stramineous, spotted black ; apical half brunneous ; costal spot stramineous : wings red, apical half fuscous : feet chestnut sanguineous (*West.*) Body long, 16½ : exp. teg. 56-57 millims.

Reported from Assam.

#### Genus ANCYRA, White.

A. M. N. H. xv, p. 34 (1845).

Allied to *Eurymela*, Hoff. ; but distinguished from it by the shape of the head which has not the dilated genæ, no stemmata, antennæ close under the eyes : tegmina finely veined, with a notch on the posterior margin and rounded at the apex, whence (in ♂) proceeds a longish narrow appendage, widest at the end : legs much dilated and compressed throughout : hind legs very long with four spines on the outer edge of the tibiæ : the end of the body covered with a waxy down-like secretion (*White*).

#### 50. ANCYRA APPENDICULATA, White.

*Ancyra appendiculata*, White, A. M. N. H. xv, p. 34 (1845) ; Westwood, Cab. Or. Ent. p. 74, t. 31, f. 5 (1848) ; Walker, List. Hom. B. M. ii, p. 395 (1851) ; Dist. ant, J. A. S. xlviii (2), p. 38 (1879).

Rich deep brown : tegmina, above brown, spotted at base with white and with two widish powdery bands of white ; beneath, mahogany red : wings deep brown almost black on the edge and between a red-coloured space : body beneath yellow : legs black : wings more powdery



in the ♀ than in the ♂ (*White*). Long  $9\frac{1}{2}$ ; exp. teg. excl. appendage 25 millims.

Reported from Maulmain: the Indian Museum possesses a specimen from Tenasserim.

# 51. ANCYRA HISTRIONICA, Stål.

*Ancyra histrionica*, Stål, Stettin Ent. Zeit. xxiv, p. 245 (1863).

Fuscous-ferruginous: frons yellow-ferruginous adorned with five subelevated, narrow, black bands: tegmina obscurely ferruginous, basal part and oblique band behind the middle, fuscous, apical callus black, apical appendage fuscous-ochraceous: abdomen flavescent (when alive sanguineous?), apex covered with a mouldy pubescence; feet blackish. Closely allied to preceding; tegmina, especially behind the middle, broader, apical appendage shorter, fuscous-ochraceous not black-fuscous, apical callus smaller, wings broader and their apical process shorter (*Stål*). ♀, long, 11; exp. teg. 26 millims.

Reported from Cambodia; the Indian Museum has a specimen from Pegu; but the desiccated body is only 8 millims long and the basal part and band behind the middle of the tegmina is lighter dull ferruginous, not fuscous.

## CORRECTION.

*C. maculicollis*, Guérin, in J. A. S. LIII (II) p. 230, No. 76, is a synonym of *Tibicen brunneus*, Fabr., as follows:—

### TIBICEN BRUNNEUS, Fabricius.

*Tettigonia brunnea*, Fabr., Ent. Syst. Suppt. p. 517 (1798); Syst. Rhyng. p. 43 (1803).

*Cicada brunnea*, Germar, Thon's Arch. ii (2) p. 6 (1830); Walker, List. Hom. B. M. i, p. 230 (1851).

*Cicada maculicollis*, Guérin, Voyage la Coquille, Zool. ii, p. 183 (1830); Walker, l. c. Suppt. p. 28 (1858).

*T. (Abricta) brunneus*, Stål, Hem. Afric. iv, p. 26 (1866).

Ferruginous or testaceous, paler beneath: apex of the scutellum and two very large spots on the thorax, ferruginous-flavescent, the latter with two fuscous streaks: head, a small posterior median spot and a transverse impression on the thorax towards the sides, blackish or fuscous-ferruginous; a spot on the lobes of the vertex, ferruginous: four triangular spots on the scutellum extended backwards from the base, fuscous; the median pair smaller, often obsolete; the lateral pair produced to a distance backwards: tegmina and wings sordid vitreous, veins testaceous-flavescent, fuscous towards the apex: head a little broader than the anterior part of the thorax: ocelli somewhat more

distant from the eyes than from each other: thorax gradually a little narrowed from the apex backwards beyond the middle (Stål). ♂, ♀, long, 21—24; exp. teg. 60—73 millims.

Reported from Mauritius, Bengal.

In J. A. S. B. LIV (II) p. 23 *Cosmopsaltria abdulla*, Distant, is recorded as a synonym of *C. spinosa*, Fabr. (l. c. LIII (II), p. 227): the following is Distant's description of *C. abdulla*.

♂. Body above castaneous, more or less covered with greyish pubescence and pilosity: head with the vertex somewhat sparingly pilose and the area of the ocelli, a little infusate: pronotum sparingly pubescent with a central x-shaped space denoted by striæ, followed by two oblique striæ, the outer one submarginal and slightly curved, lateral and posterior margins densely pubescent: mesonotum with two faintly indicated obovate spots on the anterior margin, sparingly pubescent, the lateral margins and the region of the cruciform basal elevation much more densely pubescent. Abdomen sparingly pubescent but much more densely so on the disc and the lateral margins: body beneath ochraceous: first and intermediate femora with the bases and apices fuscous, the central portion pale ochraceous: first tibiæ castaneous and tarsi piceous; intermediate tibiæ pale castaneous, with the base narrowly and the apex broadly piceous: last pair of legs pale castaneous, apices of femora, bases and apices of tibiæ, dark castaneous. Tegmina and wings pale hyaline; the former with the costal membrane and basal area, castaneous, claval area, piceous, transverse veins at bases of 2, 3, 5 apical areas infusate and a submarginal series of small fuscous spots at apices of longitudinal veins: wings with anterior claval margin and a curved basal streak dark castaneous. The face is very swollen and convex beneath, longitudinally furrowed and transversely striated: the rostrum extends just beyond the base of the femora: the opercula reach the base of the fourth abdominal segment; the outer margins are deeply narrowed and concave near the base and then become slightly convex to the apex which is broad and rounded, these opercula are very wide apart at the base and are confined to the lateral side of the under surface of the abdomen (*Dist.*).

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XIII.—*Memorandum on the Corrosion of the Lead Linings of Indian Tea Chests.*—By ALEX. PEDLER, F. C. S., *Professor of Chemistry in the Presidency College, Calcutta.*

During the last few years rather numerous instances have happened of chests of tea, apparently prepared and packed in the usual way in the tea districts of India, reaching Calcutta or England in a damaged condition; the damage consisting in the partial corrosion, and sometimes almost total destruction of the lead linings of the chests, and in the deterioration of the quality of the tea itself.

At the request of the Indian Tea Association I undertook some time since to make some experiments in order to ascertain the cause of this corrosion, and though my experiments have not yet been completed so far as I could wish, they are sufficiently far advanced to enable me, at the urgent request of the Indian Tea Association and of the the Bengal Government, to write a preliminary memorandum.

The previously published literature on this subject is remarkably meagre, and it may be summed up in a few words. On the other hand, there is reason to believe that there is a large accumulation of unpublished evidence on this subject, and it is desirable that some steps should be taken to collect and collate the mass of evidence which must have accumulated in the hands of the various agents of tea gardens, and in the hands perhaps of the more experienced planters.

The first experimental enquiry as to the corrosion of the lead linings of Indian tea chests and its cause which I can find published in scientific periodicals appears to have been carried out some time previous to 1883 by Dr. Wigner, who was then President of the Society of Public Analysts in England. He published, in Vol. II of the *Journal of the Society of Chemical Industry*, a paper entitled "The packing of substances of delicate odour such as Tea, &c."\*, in which he describes his experiments, made during the previous five or six years, in certain cases of corrosion of tea-leads in boxes made of Indian woods, the consignments of tea coming principally from Assam. The conclusions at which he arrived were that the corrosion was due to the wood used in the boxes, and his theory, though he did not adduce any specific facts as to the cause of the corrosion, was that the wood must have in some way generated acetic or other volatile acid, which, in the presence of carbonic acid and moist air, would account for the corrosion of the lead. My experiments have in almost all respects confirmed this theory.

The next contribution to our knowledge of this subject which I can

\* *Journal of the Society of Chemical Industry*, Vol. II, p. 256.



find is in a memorandum published by Dr. G. Watt, on special duty with the Revenue and Agricultural Department, Government of India, and dated Simla, June 21st, 1884. Dr. Watt makes the following statement:—"My views on the subject of woods suitable for tea boxes are at variance with the popular outcry against our Indian timbers as injuring the Indian Teas." He also states he has observed the following curious facts:—"The tea may be completely destroyed, and yet upon the most careful scrutiny not a single opening can be detected in the lead. It is obvious that until the lead is corroded any injurious influence which the timber might exert upon the tea could not take place." Again, "I have on several occasions had the pleasure of inspecting lead said to have been corroded by the action of the wood. But it is a curious fact that the action seems to commence on the inside of the lead instead of on the outside or on the surface in contact with the wood, (the supposed acid influence which decomposes the metal) has not been apparently observed." He also suggests "it may be the tea itself which corrodes the metal and not the wood."

Dr. Watt also during the Calcutta International Exhibition had an opportunity of working with 200 tea-box woods from all parts of India, and performed a large series of experiments on the action of these woods on tea-lead. He says both unseasoned and seasoned woods were used in these experiments, which were repeated once or twice, with moistened woods and under conditions intended to simulate those of the hold of a ship, and "in no instance has the lead been found to be in ever so slight a degree chemically acted on;" and finally Dr. Watt states "he failed utterly to discover any wood which seemed to possess the least chemical action upon lead."

In reply to this memorandum, Mr. Playfair, in the *Indian Daily News* of July 29th, 1884, gave the results of certain investigations on this subject, which had been made for him in London in 1883 by the late Dr. A. Voelcker, F. R. S. Dr. Voelcker's conclusions were that "the corrosion of the lead (in the Indian tea-chests) unquestionably is due to the attack of acetic or other volatile acids, and the subsequent formation of white lead (carbonate of lead) by the action of the air. Considering the fact that the surfaces of the leads which were in contact with the tea were quite bright and sound, whilst the under surfaces in contact with the wood were more or less corroded; it appears to me that in all probability green or unripe wood has been employed in making the tea-chests. Such wood is known to generate in a somewhat warm locality acetic and analogous organic acids which act upon lead."

Dr. Watt, in a long letter, dated August 13th, 1884, also to the *Indian Daily News*, discusses Dr. Voelcker's conclusions, and to a great extent

reiterates the position he had previously taken up. His conclusions may be fairly well summed up in the following statement: "The chest is full of tea which has been fermented, its fermentation arrested rapidly, and the tea is rapidly enclosed in a case and shipped to Europe. Is it improbable that the acetification of the fermented tea may not be the primary agent in the decomposition of the wood and the consequent corrosion of the lead? Having arrived at this conclusion I had little difficulty in producing from tea an acetous organic acid which rapidly corroded lead; so I have no doubt this volatile acid on escaping through the lead lining would soon establish in certain timbers, especially green and unseasoned ones, corresponding acetification, but I am convinced that we have to look to the tea itself and to some imperfection in its manufacture, as the primary exciting agent in the corrosion of the lead and the damage of the commercial article."

In view, then, of these contradictory statements as to the cause of the corrosion of the tea-leads, Dr. Wigner and Dr. Voelcker being of opinion that the cause was the wood, though of course their proof was incomplete, and Dr. Watt holding that the cause was to be found in the tea, I commenced the following experiments.

From a practical point of view the first thing which it was desirable to settle was whether the tea or the wood of the chests was the active agent in inducing the corrosion of the lead. To test this view, certain boxes of tea were specially prepared, and they were then handed over to me by the Indian Tea Association.

Three boxes represent the matter typically.

No. 1 was a half chest containing 40 lbs. of pekoe souchong tea of ordinary manufacture. The half box was made entirely of wild mango wood (*Mangifera indica*), damp and unseasoned.

After being kept in the ordinary way for several weeks this box was examined. On being opened the upper surface of the lead next the wood was found to be almost entirely covered with a white powder, which on examination was found to be principally "white lead." The lead was largely corroded over the whole surface, and in fact eaten through in certain places. There were several clear cases of perforation, and, examined under a magnifying glass, the perforations were surrounded on the upper surface with very extensive corrosion. The lead was then cut off from the chest, and the surface next the tea examined; over the greater part it was quite bright and free from corrosion, though in certain parts it was slightly tarnished. The perforations were also examined from the under surface, and there was no trace of corrosion round the edges. Even in this, which should be the most favourable position for corrosion if the corrosion is caused by the tea, no corrosion was seen.

The lead of the bottom of the box and of the four sides was examined, and the results were similar to those above described. On all the external surfaces the lead was largely corroded, and in some parts to a most excessive extent. On the inner side of the lead next to the tea, except on those parts where the lead had been entirely eaten through, the lead was perfectly bright and clean.

The surface of the wood of this chest next to the lead was also found to be distinctly acid to test paper.

The lead having been perforated in this case the corrosion was still open to the possibility of explanation in the manner suggested by Dr. Watt, though, as described above, every appearance was against it. To test this point the following experiments were made :

Pieces of the slightly moistened wood were placed with tea-lead in a large bottle with air charged with moist carbonic acid, but, after standing for some time, practically no corrosion of the lead appeared.

Some of the tea was taken under similar circumstances to the above and placed with tea lead ; the lead remained perfectly bright and uncorroded.

Some of the wood of the box was distilled in a current of steam, and the distillate tested by placing some of it at the bottom of a bottle ; a piece of tea-lead was then hung in the bottle, so that it did not touch the liquid, and the bottle was repeatedly filled with air charged with moist carbonic acid.\* The tea-lead was very distinctly corroded on standing.

Some of the tea was also distilled in a current of steam and the distillate treated as in the last experiment, but it had no corrosive action whatever on the tea-lead. Some pieces of the wood of this box were placed with water and tea-lead hung over it, but not so as to touch it, and exposed to the air. The lead was corroded very rapidly. Some of the tea was taken also placed in water and tea-lead hung over it, but not so as to touch it. For a long period there was no corrosion of the tea-lead, but after the tea had become mouldy and had decomposed for some time, then corrosion set in, but very much later than in the previous experiment with the wood.

It was highly probable, then, from these experiments that the wood was the source of the corrosion and certainly not the tea.

Examination of Case No. 2. This was a half chest containing 40lbs. of pekoe souchong tea, and made entirely of wild mango wood, which was thoroughly dry and well-seasoned, but after the tea was pack-

\* The presence of the carbonic acid and moist air is a necessary condition to produce rapid action on lead in the presence of certain exciting agents. It is also the condition which a chest of tea would probably be subjected to in the hold of a ship.



ed in the box, one side, marked "B," was well damped with fresh water and the other sides left untouched.

This chest was again kept for several weeks under ordinary circumstances, and was then examined. Five of the outer sides of the lead lining were quite free from corrosion, but the sixth surface, opposite to the plank marked B, showed very evident corrosion, and considerable amounts of lead carbonate or "white lead" were present over almost the whole surface. This side of the lead lining was examined minutely, and there was no perforation of any kind visible.

The inner side of the lead lining was also examined and the whole of the interior was perfectly bright and free from all tarnishing and corrosion. The inner side of the corroded part was examined most carefully, but not the slightest evidence of any action could be detected, nor were there any perforations on this side of the lead.

The wood (seasoned) of this box and also the tea were allowed to remain in contact with moist air containing carbonic acid for many weeks, but no corrosion took place.

In this case, as there was no perforation of the lead on the side on which the lead was corroded on the external surface, Dr. Watt's explanation cannot possibly apply, and the only logical conclusion is that the corrosion was due to the wood. This time also it will be seen the corrosion was brought about not by unseasoned wood, but by seasoned wood which had been subsequently intentionally thoroughly saturated with water.

Examination of Case No. 3. This was a half chest containing 40lbs. of pekoe souchong tea manufactured in the ordinary way, and the box was made entirely of wild mango wood, but partly seasoned and partly damp and unseasoned. The pieces of wood marked A were the damp and unseasoned wood of the box. The unmarked planks were of seasoned wood.

For examination, the tea in its lead lining was removed from the wooden box, and the lead lining presented a very curious appearance. The following is a description of it.

Side No. 1. The lead lining under the upper or broad plank showed no corrosion: this plank was not marked. The lead lining under the narrow plank, which was the lower piece and was marked A, showed much corrosion. Side No. 2. Under broad unmarked plank practically no corrosion, under narrow plank (marked A) much corrosion. Side No. 3. Under large unmarked plank no corrosion and under small or narrow plank (marked A) much corrosion. Side No. 4. Under broad unmarked plank no corrosion. Top of box under broad unmarked plank no corrosion, and under narrow plank (marked A) much corrosion. Bottom of box. The greater part of the bottom lead was practically free from corrosion, but at its edges it showed marked evidence of corrosion, particularly near two sides of box where there were pieces of wood marked A.

The lead lining was very carefully examined, and, though the lead was much corroded in parts, it showed no sign of perforation by the corrosive action.

The interior of the lead lining was examined and it showed no signs of tarnishing or corrosion or any action whatever.

This tea was again allowed to remain in contact with tea-lead for many weeks in a moist atmosphere containing carbonic acid, and absolutely no corrosion took place.

Here, again, as there was no perforation of the lead lining, Dr. Watt's explanation is untenable, and the corrosion was solely due to the use of unseasoned wood.

Two other cases of lead corrosion were drawn to my attention, and though I regret I was unable to obtain the name of the wood of which the tea boxes were made, the results of the examination are interesting.

A case of tea marked S. (No. 1.) on being opened was found to have its lead lining corroded, but not to a very great extent. The corrosion in this case was of totally different nature from that in the above cases, and thus while in ordinary cases the corrosion was white and to a certain extent pulverulent, in the case in question the incrustation was greenish-yellow in colour, and firmly adherent to the lead. The wood of the box judged externally seemed well-seasoned, but on being splintered emitted a "cheesy" odour, which flavour, I was told, had communicated itself to the tea. The wood was examined and the odour appeared to be due principally to a minute quantity of butyric acid which was present.

This wood was subjected to distillation in a current of steam, the distillate placed in a bottle with tea lead hanging over it, and the bottle was filled with moist carbonic acid; on standing one side of the lead became dull and tarnished, showing faint action or corrosion.

Another chest of tea marked S. 2. showed presently similar damage, and the wood again though apparently good and seasoned on the outside, when splintered gave off a very rank and offensive smell. This apparently was also due to a great extent to the presence of butyric acid.

The wood of S. 2. was distilled in a current of steam, and the distillate placed in a bottle with tea lead hanging over it, though not touching it, and treated with air containing moist carbonic acid, and after a short time the lead showed distinct, though not a large amount of corrosion.

These two cases are principally interesting because they show that more than one agent may sometimes be at work in this corroding action, for the results of the action in this case are markedly different from the general corroding action found in the other cases.

Six other small boxes of tea made of different kinds of wood were also examined. These boxes were made I believe of wood after seasoning in the ordinary way. They were also handed over to me by the Indian Tea Association.

No. 1. Box made of simal\* wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion both on the surface next to the wood and also on that next to the tea.

No. 2. Box made of jokee† wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion both on the surface next to the wood and also on that next to the tea.

No. 3. Box made of kudum‡ wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion both on the surface next to the wood and also on that next to the tea.

No. 4. Box made of ahm § wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion both on the surface next to the wood and also on that next to the tea.

No. 5. Box made of jowah|| wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion both on the surface next to the wood and also on that next to the tea.

No. 6. Box made of seeta¶ wood and kept in a damp atmosphere for many weeks. The lead lining was free from corrosion except on one side where there was a faint trace of a white powder on the surface next to the wood, but next to the tea, the surface of the lead lining was absolutely bright. There was again no perforation.

The woods of boxes Nos. 1 to 4, and also the tea which was contained in them, were exposed in contact with some tea lead in the damp atmosphere of a chemical laboratory for many weeks, and in this atmosphere there would be large quantities of carbonic acid and also vapours of various other acids, but no corrosion of the lead was set up, by the action either of the wood or of the tea in the boxes.

Taking then the general results of the foregoing work, it may be said the experiments prove conclusively that the active agent in the corrosion of the lead linings of these tea chests was certainly not produced from the tea which was contained in the chests, but from the wood of which they were formed.

It will also have been noticed that the corrosion was never produced

\* Probably wood of *Bombax malabaricum*.

† Probably wood of *Bischoffia javanica*.

‡ Probably wood of *Anthocephalus cadamba*.

§ *Mangifera indica*.

|| Probably wood of *Helicia robusta*.

¶ Probably wood of *Anona squamosa*.



when the wood of the box was in a *thoroughly seasoned and dry* condition, but that in every case where unseasoned wood was used corrosion of the lead was the invariable result. Again, in one instance it is shown that even where seasoned wood was used, if it be afterwards thoroughly saturated with water, it again becomes capable of producing corrosion of tea-lead, though perhaps not so violently as wood in the unseasoned state.

It therefore became desirable to determine whether this power of corrosion of tea leads was a property common to unseasoned woods in general, or whether it was only an isolated action due to the use of the wild mango wood, and for this purpose the following ten (10) samples of wood were experimented with. These samples were also prepared and handed over to me by the Indian Tea Association, and I believe they represent wood which may be commonly used for tea boxes.

The following was the method of procedure. Pairs of planks of the various kinds of wood were prepared about 3 feet long by 8 inches wide. Between each pair a sheet of tea lead was placed and the planks well screwed together. The planks with the tea lead were then exposed to a moist atmosphere for many weeks. The following are the names of the woods and their condition.

1st Pair. Wild mango wood, damp and unseasoned, the wood of the *Mangifera indica*.

2nd Pair. Wild mango wood, dry and well-seasoned. Wood of the *Mangifera indica*.

3rd Pair. Wild mango wood, dry and well-seasoned, but after these pieces were screwed together, one of them (marked C) was well damped with fresh water and the other left untouched. Wood of the *Mangifera indica*.

4th Pair. Dumboil wood, damp and unseasoned, perhaps the *Calophyllum inophyllum*.

5th Pair. Jalna wood, damp and unseasoned (ahm-jalna).

6th Pair. Tulla wood, damp and unseasoned, perhaps wood of the *Sterculia alata*.

7th Pair. Sita wood, damp and unseasoned, probably wood of *Anona squamosa*.

8th Pair. Satrang wood, damp and unseasoned.

9th Pair. Bolos wood, damp and unseasoned, probably wood of *Juglans plerocoea*.

10th Pair. Alodsake wood, damp and unseasoned.

The following is the description of the condition of the leads on examination.

No. 1. Both surfaces of lead very largely corroded, and a very considerable part of the lead entirely converted into white lead.

No. 2. One side of the lead quite bright and free from corrosion, and the other side covered with a fungus growth, which on removal showed the lead surface bright and uncorroded.

No. 3. The upper plank marked C was discoloured. (This was the plank which had been saturated with fresh water.) The lead surface next to this plank was partly covered with vegetable growth, and there was also a moderate amount of corrosion, "white lead" being present in considerable quantity.

The lower plank (seasoned wood *not* moistened with water) was clean, and the surface of the lead in contact with it was quite clean and free from all trace of corrosion.

No. 4. Both surfaces of lead were covered with vegetable or fungoid growth. The amount of corrosion seen on removing the vegetable growth did not appear to be large, but considerable quantities of white lead were found with the fungoid growth.

No. 5. The greater part of the lead was corroded and eaten entirely through, and almost the whole of the lead was converted into white lead or carbonate of lead.

No. 6. Both sides of lead were covered with vegetable growth. In certain parts of the lead there had been considerable corrosion, and a moderate amount of white lead was present.

No. 7. On both sides of the lead there was a large amount of fungoid growth and also of corrosion of the lead, much carbonate of lead was present, and in two places the lead was entirely eaten through.

No. 8. Parts of the wood had almost entirely decayed away or rotted, and the wood was an extremely soft one. Under the surface of the wood which had decayed, the lead was covered with vegetable growth and much corroded, but on the other surface of the lead, next to the wood which had not decayed, the greater part was quite clean and bright, and only a small amount of corrosion was detected.

No. 9. Both sides of the lead were much corroded.

No. 10. On the upper surface of the lead there was a moderate amount of vegetable growth, and a small amount of corrosion, and on the lower side of the lead there was a large amount of vegetable growth and a moderate amount of corrosion.

The results of the first three experiments in the above sets of wood strikingly confirm the results of the previous experiments with the tea chests, and it will be seen that unseasoned mango wood attacks lead in a moist atmosphere rather violently, also that seasoned mango wood kept dry has no action on it, but that seasoned mango wood, if it is subsequently saturated with water, becomes again in a condition in which it is able to attack lead in the presence of a moist atmosphere,

though not so violently as is the case with the unseasoned wood. Of the other seven varieties of wood, all of them in a damp and unseasoned condition, every sample corroded the lead in a moist atmosphere, some woods corroding the lead very largely and others to a smaller extent.

In order to test further the action of these woods on tea-lead each of them was distilled in a current of steam to get off any volatile substance present or produced by the action of water. The distillates were then taken, a portion of each placed in large bottles with tea lead hanging over the liquid, and the bottles filled repeatedly with moist air containing carbonic acid.

No. 1 distillate had a very musty and unpleasant odour, and had only an excessively faint acid re-action. It was treated as above when the lead was somewhat corroded at the bottom of the slip, and lead carbonate was found to be present in small quantity.

No. 2 distillate also had a very musty unpleasant odour, and the watery layer was very faintly acid. The lead surface was slightly dulled, but no actual corrosion was perceptible.

No. 3 distillate had also a musty unpleasant odour, the liquid was almost neutral in re-action. The surface of the lead was very distinctly corroded, and a small amount of lead carbonate was found.

No. 4 distillate had a musty unpleasant odour, and the liquid was faintly acid. The surface of the lead was slightly dull, and very faint traces of corrosion were found.

No. 5 distillate had a musty unpleasant odour, and the watery solution was faintly acid. The surface of the lead was slightly dull, and there was slight corrosion at a few points. Lead carbonate was present.

No. 6 distillate had a musty unpleasant odour, and the solution was faintly acid. The surface of the lead was decidedly dull and whitish, though there was only slight corrosion.

No. 7 distillate had a musty and unpleasant odour, and the liquid was certainly not acid, but distinctly alkaline. The surface of the lead was practically unacted upon.

No. 8 distillate had a slight ethereal smell but also a musty unpleasant odour; the liquid was alkaline. The lead surface was almost bright and there was practically no corrosion.

No. 9 distillate had a musty unpleasant odour, and the liquid was distinctly alkaline. The lead surface was almost bright, and there was practically no corrosion.

No. 10 distillate had a musty unpleasant odour and the liquid was almost neutral. The surface of the lead was distinctly tarnished, and a small amount of corrosion was visible; small amounts of lead carbonate were present.



The action of these woods on lead was tested in another way by macerating samples of the splintered wood in water, evaporating till a fairly concentrated extract of the soluble principles of the wood was obtained, and then painting the surface of some tea-lead with the extract, and exposing the lead so prepared to the action of moist carbonic acid and air.

|        |         |                                          |
|--------|---------|------------------------------------------|
| No. 1  | sample. | The lead scarcely acted on.              |
| No. 2  | "       | " " " " " "                              |
| No. 3  | "       | " " " " " "                              |
| No. 4  | "       | A small amount of lead carbonate formed. |
| No. 5  | "       | Slight amount of lead carbonate formed.  |
| No. 6  | "       | " " " " " "                              |
| No. 7  | "       | Practically no action on the lead.       |
| No. 8  | "       | " " " " " "                              |
| No. 9  | "       | Slight amount of lead carbonate formed.  |
| No. 10 | "       | " " " " " "                              |

The amount of action in this set of ten experiments, and also in the previous set of ten experiments with the distillates in steam of these woods, was in all cases comparatively slight, and it was not to be compared in extent or in nature, to the action which the same woods had produced originally on the tea-leads which had been packed between them; and the conclusion which naturally suggests itself from this is, that the cause of corrosion does not pre-exist in the wood in the condition of a volatile substance, and that it is not present to any large extent in the solution obtained by extracting the wood with water.

Taking these results then in connection with those previously detailed, it is clear that the corroding substance, whatever it may be, must be formed gradually in the wood, and that the formation is connected with the continued presence of moisture, or with the wood being in a damp and unseasoned state, and also that the active agent in the corrosion is a volatile body.

The next step in the investigation of the subject is clearly to trace out the active agents which induce the corrosion of the tea-lead, and, in order to do this, I thought it desirable to observe the action of tea-lead when placed in contact with vapours of various classes of substances which might induce corrosion, or which under certain circumstances might be produced from wood, and in the presence of moist air and carbonic acid also induce corrosion. My reason of course for working only with the vapours of these substances was that in all the cases of corrosion I had examined there were always parts of the corroded lead which were not in actual contact with the wood, and which therefore could

only have been corroded by the agency of some vapourous body, and also that the active agent of the corrosion was volatile in a current of steam in almost all cases.

Lead is a metal which, it is well known, is easily corroded by certain substances, and the most important case is the action which is employed on an enormous scale in the manufacture of white lead or carbonate of lead by the Dutch process. In this process sheets of lead rolled up in spiral form are exposed in earthenware vessels, which contain a very small quantity of acetic acid or vinegar; these vessels are then stacked together and surrounded by decomposing tan or other organic material, which on standing under the influence of moisture, heats and evolves carbonic acid. The quantity of acetic acid used in such operations is very small, less, I believe, than one per cent. of the lead operated upon, and yet the lead under the influence of this minute quantity of acetic acid, and in the presence of moist air and carbonic acid at a slightly elevated temperature, is very rapidly corroded, and finally becomes almost entirely converted into white lead, which, as is well known, consists of carbonate mixed with hydrate of lead, and which, as produced in the first instance, contains minute quantities of lead acetate adhering to it, the acetate being afterwards removed by washing with water before the article is sent into commerce.

The first series of bodies the action of which I tried on tea lead, was the group of organic substances to which acetic acid belongs. In organic chemistry there is a large group of fatty acids as they are called, of which acetic acid stands next to the lowest, and which acids possess a precisely similar constitution, and act usually in precisely similar ways. These acids are homologous, only differing in composition by a well known increment of carbon and hydrogen. The lowest members only of this series are volatile, and I experimented with the five lowest with the following results. The mode of experiment was simple: a drop or two of the acid was placed at the bottom of a large bottle, a strip of tea lead was then hung in it, but not so as to touch the acid and the bottle filled with moist carbonic acid and air, the carbonic acid being renewed from day to day, or at frequent intervals as seemed necessary. The action then could only take place between the lead and the vapour of the acid, and the carbonic acid and moist air.

The first or lowest member of this series is Formic acid, and under its action the lead surface became dull and corroded to a small extent. There was a grey coherent film adhering to the lead and little or no white incrustation. The film on examination appeared to be Lead formate, and it is therefore evident that formic acid does not act on lead in the same way that acetic acid does.

Acetic acid in very small quantity was tested in the same way; the lead in a few hours was entirely covered with a film of white lead; in twenty-four hours the greater part of the lead had been corroded and destroyed, and in thirty-six hours the lead had been entirely eaten through, and converted into white lead with a small quantity of lead acetate present in it as usual.

Propionic acid, the third member of the series, after a few days had corroded the lead rather rapidly, and the greater part of the lead was entirely eaten through. The greater part of the lead was converted into the carbonate, though some soluble propionate was found.

Propionic acid then acts on lead in a manner analogous to acetic acid.

Butyric acid was tried in a similar manner, and after standing some days the lead was more than half eaten through, and the surface was covered with a moist yellowish green deposit. The lead was to a considerable extent converted into lead butyrate, but lead carbonate was also present in small quantity. Butyric acid therefore acts on lead in a manner analogous to acetic and propionic acid, but far more feebly.

Valeric acid, the fifth and last member of this series tried, caused a large amount of action on the lead, the surface of which became covered with a greenish yellow incrustation, and on some parts of which considerable amounts of crystalline scales were present. A large part of the corrosion was due to the formation of lead valerate, but a small amount of carbonate was also present.

Valeric acid therefore acts on lead in the same way as acetic, propionic, and butyric acid, but the production of the carbonate is much more feeble.

A most interesting point in the case of the last two bodies, butyric and valeric acids, is that the incrustation on the lead was strikingly analogous to that found in the rarer form of corrosion in tea chests as described under the cases S. 1. and S. 2.

Other but less volatile organic acids, such as Benzoic acid etc., were tried, but they produced no appreciable action on lead.

Hydrochloric acid in the same way was tried and the lead surface became covered with chloride of lead with which a minute trace of carbonate was mixed.

Nitric acid tested in the same way caused very rapid corrosion, the product of the action appearing to be either a basic nitrate or a mixture of nitrate and hydrate.

Ammonia acted on the surface of the lead to a small extent, and converted it partly into oxide.

A series of alcohols, consisting of methylated ethyl alcohol, ethyl alcohol, propyl alcohol, butyl alcohol and amyl alcohol, was tried, but beyond a slight superficial action no corrosion was found to take place.



A series of essential oils was then tried, including oils of anise, bergamot, cinnamon, cloves, eucalyptus, lemon, peppermint, and turpentine, and also camphor, menthol, and thymol. In almost all the cases of the oils, slight corrosion of the lead into oxide and carbonate was found. It was therefore clear that these oils facilitate the action of moist carbonic acid and air on lead. In no case however had the corrosion proceeded to any large extent, and it consisted only of a kind of white film or bloom on the surface of the lead, such as is frequently seen in tea chests when there appears to have been a tendency to action, though no actual corrosion. In the case of camphor, menthol and thymol the lead was perfectly unacted upon.

Other tests have been made, but they need not be here described, and so far as my experiments have gone they indicate that the only class of organic substances which is capable of producing rapid chemical action on tea-lead in the presence of moist air and carbonic acid is the class of fatty acids or the acetic series of acids. Of these formic acid does not produce any carbonate of lead; the action of acetic acid, as is well known, is violent; that of propionic acid is of similar nature but less violent: the principal products of the action being in these two cases white lead; and finally butyric and valeric acids produce yellowish green incrustations on lead which contain only small quantities of carbonate.

The next point which I have endeavoured to work out is to trace the actual active agent which induced the corrosion in some of the cases described in the first part of the paper, and for this purpose a more minute investigation was made into the products of the corrosion of the leads. Four of the leads which had been much corroded in the ten samples which had been placed between boards were taken. The numbers selected were No. 1. Wild mango wood, No. 4. Dumboil wood, No. 5. Julna wood, and No. 8. Sita wood.

In the corroded lead of No. 1., the material was principally lead carbonate and lead hydrate; acetic acid was also distinctly detected by several tests, so that the active agent in the corrosion of this lead was clearly acetic acid. In the corroded lead of No. 4., the material was again principally lead carbonate and hydrate; acetic acid was also clearly detected, but the quantity present was very minute. In the corroded lead of No. 5, again, the corroded material was mainly lead carbonate and lead hydrate; acetic acid was tested for and detected with great ease, and the quantity was comparatively large, sufficiently large to convert the acid into barium acetate, which presented the usual properties, but the quantity was not large enough for a quantitative analysis. In the corroded lead of No. 8, the principal material was lead carbonate and hydrate, but the presence of acetic acid was also clearly detected.

Evidently then the action which has taken place in the case of these woods in contact with the tea-lead has been identical with that previously described as the Dutch method of making white lead. Acetic acid was present in minute quantity, moist air and carbonic acid have also been present at a comparatively high temperature, and thus all the conditions were favourable for the production of white lead.

The conclusion, then, at which I arrived was that the corrosion was produced by the unseasoned, or moistened wood, and that acetic acid was the active agent in the corrosion. In order to further test the point, I made extracts from the various samples of wood numbered 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10, and distilled these extracts with dilute sulphuric acid. In all cases a distillate of distinctly acid and acetous smell was obtained, evidently showing the presence of small quantities of acetic or some analogous acid in combination in these woods.

The final point which then remains to be cleared up is the origin of the acetic acid from the wood, for, as previously pointed out, it evidently does not exist in the first instance ready formed in the wood, but is produced by some secondary action. Dr. Wigner in the publication previously referred to put forward a very probable theory. He remarks "The sap of wood invariably contains sugar. The quantity is small, but still measurable. This sugar is in every case, which has come under my knowledge, a fermentable sugar, and the first result of the fermentation is in most cases alcohol. Fermentation being carried a step further free acetic acid is the natural result. With the formation of acetic acid carbonic acid is also formed ... Transferring this from a theoretical to a practical case: A wood containing sap which was more than usually saturated with sugar, and exposed to a moist heat, would ferment more readily, would produce a larger quantity of alcohol, would consequently produce a larger quantity of acetic acid, and would therefore, by inference, derived from practical work, produce a larger amount of carbonic acid, and thence of white lead. These effects would be produced mainly, if not entirely, upon the surface of the wood, and one of these surfaces would be in contact with the metallic lead which forms the lining of the case. Now let us see what would take place. The lead lining would be exactly in the same condition as the lead in a leadstack which was being worked by the Dutch process. Acetic acid, carbonic acid, and moisture would all be present. There would be a reasonable and probably, in accordance with practice, a very proper degree of heat, and the lead and wood would be in contact; and it seems the most natural thing in the world to assume that, as the result, acetate of lead would be formed by the direct action of the acetic acid. Carbonate and hydrate of lead would be formed from this by the action of the carbonic acid and the

moisture in the air, and although the two chemical changes would run on almost concurrently, yet the result would be the direct formation of a film of white lead."

The samples of wood Nos. 1 to 10 were therefore tested to see whether any fermentable sugar could be detected in them. It must, however, be remembered that these woods had already produced their corrosion, and according to the above theory a part, if not the whole, of the fermentable sugar contained in the wood would have disappeared in the process. Of the ten samples No. 1 wild mango wood was tested most carefully, and very distinct indications of a fermentable sugar were obtained. No. 5 jalna wood and No. 9 bolos wood also gave clear indications of fermentable sugar, and in the case of Nos. 2, 3, and 8 as well, there appeared to be traces of this substance, but in Nos. 4, 6, 7, and 10, I could not detect any indications of fermentable sugar at all.

The presence of fermentable sugar in small quantity in the wood is certainly a probable cause of the formation of acetic acid, but wood contains other ingredients besides. Thus, for instance, some kind of starchy matter is a nearly constant ingredient of the stems of trees, and forms the chief bulk of the reserve matter out of which leaves and shoots are produced in spring. The presence of starch is also in some way connected with the presence of sugar, for experiments have proved clearly the existence of varying amounts of sugar in fruit trees, and also that the sugar reaches its maximum in the spring when the starch is undergoing solution. Starch also in the condition in which it is found in unseasoned wood under the continued influence of heat and moisture will undoubtedly suffer decomposition, and the products of decomposing starch, as is well known, are of a decidedly acid character, and of the acids formed, some are of the acetic series, and of these butyric acid may be recognized.

The sap of woods has also been investigated and one of the principal constituents is sugar. Of the presence of carbo-hydrates other than sugar no definite evidence exists, but in the cases which have yet been investigated malic acid was also present in the sap. Now malic acid is a substance on which the action of putrefactive ferments has been tried, and the products of the fermentation are carbonic acid, acetic acid, succinic acid, and butyric acid.

I regret that up to the present time I have not been able to investigate the sap of any Indian trees, nor have I found malic acid in the woods experimented on, but given the probable, if not the almost certain presence of small quantities of malic acid in the sap, and given the conditions of heat, moisture, etc. to set up putrefactive fermentation in the moist and unseasoned wood, the presence of all the substances necessary to corrode tea-lead will at once follow.



In the case of an unseasoned wood, the sap will still be present in small quantity, and thus the presence of acetic acid, butyric acid, etc., may be readily accounted for, if the wood is placed under circumstances of heat and moisture favourable to the production of fermentation.

The conclusions that my experiments have led me to form are as follows :—

1. That tea properly manufactured in the ordinary way has no power to corrode lead.

2. That if unseasoned and damp wood is used for the manufacture of the tea boxes, corrosion of the tea lead is, under favourable circumstances, almost certain, but that some varieties of wood act more violently than others.

3. That even if seasoned wood be used to make the tea boxes, and if it be allowed to become saturated with water, and then placed in favourable circumstances of heat and moisture, corrosion of the tea lead may occur, though not to so great an extent as if unseasoned wood had been used.

4. That the active agent does not exist ready formed in unseasoned wood, but is produced by a secondary action from the constituents of the wood.

5. That the corrosion is not usually due to contact action between the lead and the wood, but that a volatile substance is gradually produced from the unseasoned wood.

6. That the corroding agent is usually acetic acid in the presence of moist air and carbonic acid, but that other acids of the same series are sometimes produced, and also act on the lead, and in the case of butyric and valeric acids a greenish yellow incrustation is formed differing entirely from the whitish or yellowish incrustation produced from acetic acid.

7. That the acetic and other acids are produced by the decomposition (probably by a kind of fermentation under the influence of heat and moisture, and perhaps started by decomposing nitrogenous matters) of certain substances which are known to be present in woods. Such bodies are fermentable sugars, starchy matters, malic acid, etc.

8. That the lead linings of the tea chests having been corroded and perforated by the corroding action of these acids in the presence of moist air and carbonic acid, the tea can easily take up the disagreeable odour which the wood itself will possess, after it has undergone the change in which acetic and butyric acid, etc., are formed, and thus the quality of the tea will be deteriorated.

XIV.—*Indian Ants of the Indian Museum, Calcutta.*—By PROFESSOR AUGUST FOREL, Zurich. Communicated by the NATURAL HISTORY SECRETARY.

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Family FORMICIDÆ.

I. Subfamily **Camponotidæ.**

Forel, Zeitschr. f. wiss. Zool. xxx, Suppl. 1878.

Genus CAMPONOTUS.

Mayr, Europ. Formic. 1861.

1. CAMPONOTUS SYLVATICUS, Olivier (Encyclop. Méth. Hist. Nat. VI).

Subspecies *C. cognatus*, Smith (Cat. Brit. Mus. 1858), var. *e*, Mayr (Ants of Turkestan coll. b. Fedtschenko), ♂ and ♂.\*

The *Camponotus sylvaticus* is a large species, which is divided into many subspecies and varieties, and which occurs throughout the world. The subspecies *cognatus*, var. *e*, inhabits Africa and South Asia.

2. CAMPONOTUS MICANS, Nylander (Annal. d. Sc. Nat. IV), ♂.

This species is found in Europe, Africa, and India.

3. CAMPONOTUS OPACIVENTRIS, Mayr (Verhandl. k. k. zool.-bot. Ges. Wien, 1878), ♂.

Species very closely allied to the *C. sericeus*, Fabr.

4. CAMPONOTUS IRRITANS, Smith (Catal. Brit. Mus. 1858) (= *Camp. inconspicuus*, Mayr, Ann. Mus. Civ. Genova, 1872), ♂.

Genus POLYRHACHIS.

Shuckard, Hist. of Insects.

5. POLYRHACHIS LEVISSIMA, Smith (Catal. Brit. Mus. 1858) (= *Polyrhachis globularia*, Mayr, Tijdschrift voor Entomologie 1867), ♂.

Genus PRENOLEPIS.

Mayr, Europ. Formic. 1861.

6. PRENOLEPIS LONGICORNIS, Latr. (Hist. Nat. Fourmis, 1802), ♂. A cosmopolitan species.

Genus CECOPHYLLA.

Smith, Proc. Lin. Soc. Zool. 1860.

7. CECOPHYLLA SMARAGDINA, Fabr. (Spec. Ins. I) (= *Formica virescens*, Fabr., Syst. Ent. 392 = *Formica longipes*, Jerdon, Madras Journal Lit. & Sc. 1851), ♂.

This species is also found of a green colour.

\* ♂ is the sign for "worker"; ♀, for "female"; ♂, for "male"; and ♀, for "soldier."

Genus ACANTHOLEPIS.

Mayr, Europ. Formic. 1861.

8. ACANTHOLEPIS FRAUENFELDI, Mayr (Form. Austr. 1851), ♀.

This species has been hitherto known only from the Mediterranean country, Aden, Turkestan, and Persia. The specimens from Calcutta would belong to the variety *bipartita*, Smith (Proc. Lin. Soc. Zool. 1861); but the body is of a dark brown-blackish colour. They are large (3 millims.) and opaque.

The mesothorax of this genus is much narrowed in the middle, like the waist of a slender lady.

II. Subfamily Dolichoderidæ.

Forel, Zeitschr. f. wiss. Zool. xxx, Suppl. 1878.

No representative of this subfamily was among the ants sent from Calcutta.

III. Subfamily Poneridæ.

Smith, Cat. Brit. Hym. 1851.

Genus PONERA.

Latreille, Gen. Crust. et Ins. 1806-1809.

9. PONERA TESSERINODA, Mayr (Verhandl. k. k. zool.-bot. Ges. Wien, 1878, *nec* Emery, Ann. Mus. Civ. Genov. IX, 1876-77), ♀.

10. PONERA LUTEIPES, Mayr (Myrmecol. Studien, 1862), ♀.

Genus DIACAMMA.

Mayr, Myrmec. Studien, 1862.

11. DIACAMMA VAGANS, Smith (Journ. Linn. Soc. Zool. V, 1860, Roger (Berl. ent. Zeitschr. 1860, p. 304), ♀.

Genus LOBOPELTA.

Mayr, Myrmec. Studien, 1862.

12. LOBOPELTA CHINENSIS, Mayr (Neue Formiciden, 1870), ♀.

The specimen from Calcutta is only 8.5 millims. in length. Mayr's specimens were larger (9.5—10 millims.).

13. LOBOPELTA KITTELI, Mayr (Neue Formiciden, 1870), ♀.

IV. Subfamily Dorylidæ.

Shuckard, Ann. of Nat. Hist. v, 1840.

Genus TYPHLOPONE.

Westwood, Introd. Class. Ins. 1840.

14. TYPHLOPONE ORANIENSIS, Lucas (Expl. de l'Algérie, 1840-42), ♀.

This species has been hitherto known only from Northern Africa and from Asiatic Turkey. The specimens from Calcutta are quite identical with specimens from Algeria and Palestina in my collection.



V. Subfamily **Myrmicidæ.**

Smith, Cat. Brit. Hym. 1851.

Genus **SIMA.**

Roger, Berl. ent. Zeitschr. 1863 = *Eciton* Jerdon, nec Latreille.

15. *SIMA RUFO-NIGRA*, Jerdon (Madras Journ. Lit. & Sc. 1851, *Eciton*), ♂.

16. *SIMA COMPRESSA*, Roger (Berl. ent. Zeitschr. 1863?), ♂.

The only specimen from Calcutta is very large (7.5 millims.) The specimens which were described by Roger (l. c.) and Mayr (Tijdschr. voor Entomol. 1867) measured only 4--5 millims. Therefore the identity of our specimen with *S. compressa* does not seem to me to be perfectly sure, though the other characters agree with the description.

Genus **MYRMICARIA.**

Saunders, Trans. Ent. Soc. Lond. 1841-43 = *Heptacondylus* and *Physatta*, Smith.

17. *MYRMICARIA SUBCARINATA*, Smith (Cat. Brit. Mus. 1858, *Heptacondylus*), ♂.

Genus **HOLCOMYRMEX.**

Mayr, Verh. k. k. zool.-bot. Ges. Wien, 1878.

18. *HOLCOMYRMEX SCABRICEPS*, Mayr (Verh. k. k. zool.-bot. Ges. Wien 1878), ♂ major and ♂ minor.

Genus **PHEIDOLE.**

Westwood, Ann. & Mag. Nat. Hist. vi, 1841 = *Ocodoma*, Jerdon, l. c.

19. *PHEIDOLE INDICA*, Mayr (Verh. k. k. zool.-bot. Ges. Wien 1878), ♂, ♀, and ♀.

The specimens are smaller than Mayr's. I have submitted this ant to Prof. Mayr, who has pronounced it to be his *P. indica*; but joints 3--4 of the antennæ are longer than broad in the soldier, as long as broad in the female.

♂. Length: 4--5 millims. A curved striation at the posterior angles of the head. Head shining between the striæ.

♀. Length: 2.5--2.8 millims.

♀. Length: 7--7.5 millims. Head narrower than the thorax.

20. *PHEIDOLE LATINODA*, Roger (Berl. ent. Zeitschr. 1863), ♂, ♀, and ♀, var. *MAJOR*.

The specimens are larger than Roger's and Mayr's. This species has hitherto only been found in India, and the ♀ is still unknown.

♂. Length: 5.4--6.2 millims. Head coarsely striate-rugose, posteriorly coarsely rugose-reticulated. The ground of the reticulations is moderately shining and sometimes contains secondary rugosities. Less shining than *P. indica*; the clypeus carinate (in *P. indica* not carinate);

the basal surface of the metanotum transversely rugose. The first node of the petiole anteriorly almost broader than posteriorly; beneath, furnished with a longitudinal carina. The second node very broad, nearly three times as broad as the first. Tibiæ and scapi of the antennæ abundantly furnished with long erect hairs.

♂. Length 3—3.3 millims. Antennæ and legs very long and slender, with abundant long erect hairs. First node of the petiole convex beneath. Spines of the metanotum longer and at the base narrower as in *P. indica*.

♀. Length: 7.5—8 millims. Head (without the mandibles) broader than long, broader than the thorax, little shining. Thorax narrow and short. Mesonotum longitudinally rugose (wrinkled). The wrinkles converge anteriorly and anastomose together at the median line in front. Mesonotum opaque, granulated between the wrinkles. Scutellum smooth and shining. Metanotum between the spines with some coarse longitudinal wrinkles laterally, smooth and shining in the middle.

Nodes of the petiole very broad. The first is short and bears upwards a much broadened transverse scale, which is emarginate at the middle of its superior margin. The first node with a longitudinal, lobi-form, very prominent edge beneath. The second node twice as broad as the first, and nearly three times as broad as long, coarsely rugose with an obtuse tooth beneath. The anterior half of the basal segment of the abdomen closely striate-rugose, the posterior finely and closely reticulate-punctured, opaque. The anterior two-thirds of the following segments smooth and shining; their posterior third reticulate-punctured and opaque.

Wings pale yellowish.

In other respects like the soldier.

#### 21. *PHEIDOLE JUCUNDA*, n. sp.

This species resembles *P. javana*, Mayr, and *P. indica*, Mayr. The soldier only is known.

♀. Length: 3.3 millims. Head (without the mandibles) rectangular, a little narrowed posteriorly, deeply emarginate and a little flattened behind (like the *P. latinoda*), relatively small. The anterior half of the clypeus carinate. The anterior edge of the clypeus emarginate in the middle. Mandibles shining, very delicately striate-rugose, with scattered punctures and with two blunt teeth at the apex. Scapus of the antennæ lodged in a distinct, smooth, longitudinal groove, which is edged medially by the very long frontal edges (*laminæ frontales*). Scapus of the antennæ very long; but not quite reaching the posterior angles of the head. Joints 3—6 of the funiculus of the antennæ as broad as long.

Mesonotum with a deep transverse impression, which is nearly as deep as the meso-metanotal groove. Basal surface of the metanotum narrow, with a very distinct, abruptly edged longitudinal channel in the middle. Spines of the metanotum of moderate size, divergent, near one another at the base. The nodes of the petiole have the usual form; the second node rounded, without lateral conuli. Antennæ and legs rather elongate.

Head coarsely and longitudinally striated in the middle; striate-rugose, then reticulate-rugose at the sides, very coarsely rugose-reticulate at the posterior angles (like *P. latinoda*). Frontal area and middle of the clypeus nearly smooth. Thorax wrinkled and rugose, moderately shining. The sides of the mesonotum and metanotum, as also the declivous (posterior) surface of the metanotum finely reticulate-punctured and opaque. Nodes of the petiole finely reticulate, nearly opaque. The base of the abdomen very delicately reticulate; the rest smooth and shining with some scattered punctures, with a hair in each point.

Head and abdomen sprinkled moderately with erect hairs. A few scattered erect hairs on the thorax and the femora. The tibiæ and scapi without erect hairs, only with a delicate quite applied pubescence. The body nearly without applied pubescence.

Dark ferruginous-red. The posterior three-fourths of the head, the scapi, and the abdomen (its base excepted) dark chestnut-brown.

This species is easily to be distinguished from the *Ph. latinoda* by its smaller size, its tibiæ and scapi without erect hairs, the nodes of its petiole, etc.; from the *Ph. indica* by its carinate clypeus, its more emarginate head with the posterior angles coarsely reticulate-rugose, etc. The closely allied *Ph. javana* has very abundant erect hairs on the legs and on the antennæ, the metanotal spines much removed from another at the base, the clypeus without carina, etc.

## 22. PHEIDOLE WOOD-MASONI, n. sp.

I dedicate this pretty little new species to Prof. J. Wood-Mason, who has been so kind as to send it to me with the others noticed in this paper.

♀. Length 2.6 millims. Head elongate, rectangular, slightly emarginate behind. Eyes very minute, each compounded of about 20 facets, situated at the anterior quarter of the head. Antennæ very short; scapi of the antennæ as long as half the breadth of the head, either as long as two-fifths of the length of the head (without mandibles). Antennæ 12-jointed, with very large club; the last joint as long as the two precedent together. Joints 2—6 of the funiculus twice as broad as long. Mandibles smooth, shining, with very scattered punc-



tures and with two black teeth at the end of the terminal edge. Clypeus very short, very deeply and broadly emarginate at the middle of its anterior edge, as smooth in its middle part even as the frontal area, longitudinally striated at the sides. Antennal fossæ very near to the anterior edge of the head. Frontal edges as long as the scapi. At their exterior side is a smooth and shining groove in which the scapus is lodged. The anterior half of the head is longitudinally striated; the posterior is smooth, shining, with some scattered puncture, with a hair in each point.

Thorax very short. The pronotum is broadened and forms at each side an edged and rounded protuberance. The pronotum and the mesonotum form together only one convex, smooth, and shining hump, without transverse impression. The meso-metanotal groove is very distinct. Metanotum low; its basal surface with two minute longitudinal edges at the sides, which terminate each in a triangular tooth (instead of the spines). The basal surface of the metanotum delicately transversely reticulate, the declivous one delicately transversely reticulate-rugose.

The nodes of the petiole have the usual form. They are narrow and microscopically reticulate. Abdomen smooth and shining with large golden concave points on its first segment. The whole body, inclusive of the tibiæ and of scapi, covered with erect hairs.

Yellow. The anterior edge of the clypeus and the anterior half of the mandibles darkened; the terminal edge of the mandibles blackish.

♂. Length: 1.5 millim. Stature relatively short and thickset. Head oval, not emarginate. Antennæ like those of the soldier. The scapi reach the posterior edge of the head. Mandibles smooth, shining, with scattered puncture and eight teeth. Clypeus entire, smooth and shining like the whole head. Eyes very minute, situated on the anterior third of the head, and each compounded of about 12 facets. No groove for the scapi. Thorax as in the soldier, but the metanotum is less low. Metanotum with two minute teeth, extremely finely and transversely wrinkled between these teeth. Nodes of the petiole microscopically reticulate. A very large brownish and gilt puncture on the abdomen. This puncture is more abundant than that of the soldier, and even more abundant than in *Tetramorium auropunctatum*. The erect hairs of the body are a little more scattered and those on the tibiæ and scapi more oblique than in the soldier.

Entirely yellow, with the terminal edge of the mandibles darkened and the puncture of the abdomen brownish (and gilt).

#### Genus PHEIDOLOGETON.

Mayr, Myrmecol. Studien, 1862.

23. PHEIDOLOGETON LABORIOSUS, Smith (Proc. L. S. Zool. 1861, *Solenopsis*), ♂ major.

Genus SOLENOPSIS.

Westwood, Ann. & Mag. Nat. Hist. vi, 1841.

24. SOLENOPSIS GEMINATA, Fabricius (Syst. Piezat. 423, 1822, *Atta*),  
♂ major and minor, ♀, and ♂.

One of the commonest cosmopolitan tropical ants.

Genus MONOMORIUM.

Mayr, Formic. Austr. 1855.

25. MONOMORIUM LATINODE, Mayr (Ann. Mus. Civ. Genova, 1872), ♂.

Genus MERANOPLUS.

Smith, Trans. Ent. Soc. Lond. 1853.

26. MERANOPLUS BICOLOR, Guérin (Icon. Règn. Animal 1829—38,  
*Cryptocerus*), ♂.

A further *Pheidole* ♂ is not to be determined without the correspondent soldier, worker, or female.

All the species included in the foregoing list were obtained in the neighbourhood of Calcutta.

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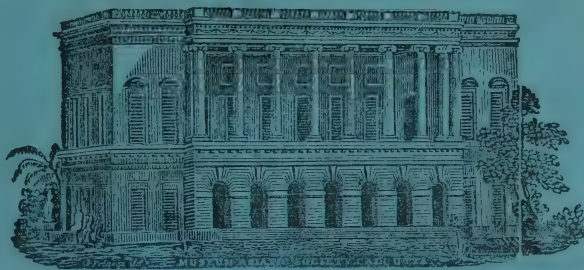
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